Imprimatur;

Guil. Jane R. P. D. *Hen.* Episc. *Lond.* à Sacris Dom.

Utilis THE Codex.—

The Artist's *Vade Mecum*:

go with me

OR THE

Most Useful Arts AND SCIENCES

Improv'd and made Easie.

Containing

1. The Curious Art of Dialing, in Drawing and Placing all sorts of Sun-Dials by a true, at least or more exact Rule than hitherto found out. 2. Geometry applied to the most profitable Arts of Surveying, Measuring Timber, or any solid Bodies; Gauging Casks, Brewers Tuns, Wine-Vessels, &c. 3. Finding the Length and Circumference answering to any Arch, in Degrees and Decimal Parts. 4. The Area or Segments of a Circle, whose whole Area is Unity, to the Ten Thousandth Part of the Diameter; with many other useful Tables, ready stated. 5. A compleat Body of Astronomy, or a View of the Cælestial Globe; Places of the Sun, Moon, and Fixed Stars, the Names of the most noted Stars, in what Signs they are posited; their Longitude and Latitude, &c. The Doctrine of the *Primum Mobile*, and the Account of Time Rectified and Freed from Error; compared with the *Julian* and *Gregorian* Calenders.

To which is added,

A Compleat Body of Geography; describing all the Empires, Kingdoms, and States in the known Parts of *Europe*, *Asia*, *Africa* and *America*. The like never before made publick; illustrated with 14 Copper-Plates.

Jos. Blydgett

By Dr. Colton.

LONDON: Printed for *Eben Tracy*, at the *Three Bibles* on *London-Bridge*, 1698.

64 — 516

Syrian Year

1	Tishrin	31. begins 1st Oct.	7	Nisan	30
2	Latter Tishrin	30	8	Aiyar	31
3	Canun	31	9	Haziram	30
4	Latter Canun	31	10	Shamuz	31
5	Shabat	28 or 29 in L.Y.	11	Ab	31
6	Adar	31	12	Elul	30

Persian or Yezdezerdic Year

1	Asrudia meh.	30	7.	Mehar meh	30
2.	Ardibascht meh.	30	8.	Aben meh	30
3	Cardi meh	30	9	Adar meh	30
4	Shir meh	30	10	Di meh	30
5	Merded meh	30	11.	Behen meh	30
6	Schabarin meh	30	12	Assiren meh	30 + 5 Interc

Arabic or Turkish Year

1	Muharram	30.	5.	Jomada	30.	9	Ramadan	30
2.	Saphar	29	6	Lat. Jomad	29.	10	Shawal	29
3	Rabia	30	7.	Rajab	30.	11	Dulkaadah	30
4.	Latter Rabia	29	8	Shaaban	29.	12	Dulheggia	29 bu

in every embolismic year 30. 1 day is added every 2
5th 7th 10th 13th 15th 18th 21st 24th 26th and 29th in a
cycle of 29 years. this year consists of 354d 8h 48m

Ethiopic year

1. Mascaram	5. Tyr	9. Ginbat
2 Tykympt	6 Jacatil	10. Syne
3. Hydar	7. Magabit	11 Hamel
4. Tyshas	8 Mijazia	12 Hahase

Intercalary days 5. It commences with the Egyptian year, on the 29th of Augt. of the Julian Year and is Solar.

Greek Year

Comm. at the new moon nearest to the Sum. Solst.

1. Ekatombaioon 29, 2 Metageetnioon 30,
3. Boedromioon 29, 4 Maimakterioon 30,
5 Puanepsioon 29, 6, Poseideoon 30; 7. Gamelioon
29; 8 Anthesterioon 30; 9 Elapsebolioon 29; 10
Mounuchioon 30; 11 Cargelioon 29. 12 Skirophorioon 30

TO THE

Most Honourable

HENRY SOMERSET,

Lord Herbert, *Baron of* Chepstow, Raglan, *and* Gower, *Earl and Marquess of* Worcester, *Lord President and Lord Lieutenant of* Wales *and the* Marches, *Lord Lieutenant of* Gloucester, Hereford *and* Monmouth, *and of the City and County of* Bristol, *Knight of the Most Noble Order of the Garter, and one of His Majestie's Most Honourable Privy Councilors*

HE that adventures upon any thing contrary to the General received practice, what ever his own courage and resolutions are, had need to be supported, not only by the most Wise and Honourable, but also

the most Powerful Persons that are in a Nation or Kingdom; For let the Proposals be never so advantagious to the Publick, they shall not only be decried and neglected, but it is well, if the Promoter be not both abused and ruined: Yet I, notwithstanding all these discouragements, have not been silent, but in order to Childrens better Education, have long since published my thoughts, *and have and do declare, that the multitude of Schools for the learning of the Latine and Greek Tongues, are destructive both to our youth and the Commonwealth*; and if the Opinion of Sir *Francis Bacon* in his Advice to King *James* concerning *Sutton*'s Hospital, be not sufficient to warrant my Assertion, I could heartily wish that no such Evidence could have been produced, as the late unhappy Wars, in the Bowels of this Kingdom hath afforded us; for what he saith there by way of Advice, we by woful Experience have found too true; that by reason of the multitude of Grammar Schools, more Scholars are dayly brought up, than all the Preferments in this Nation can provide for, and so they become uncapable of other Professions, and unprofitable in their own, and at last become, *materia rerum novarum*; whether this be an essential or an accidental Effect,

I will

I will not here dispute; the truth of it, I am sure, cannot be denied: but that is not all; by this means it comes to pass, that four of the seven Liberal Arts, are almost wholly neglected, as well in both Universities, as in all Inferiour Schools; and setting aside the City of *London*, there are but few Places in this Nation, where a man can put his Son, to be well instructed in *Arithmetick*, *Geometry*, *Musick* and *Astronomy*; and even that Famous City was without a Publick School for Mathematical Learning, till His present Majesty was pleased to lay the Foundation; nay so averse are men in the general to these Arts (which are the support of all Trade) that without a high hand, it will be almost impossible, to make this People wise for their own good: I come therefore to your Honour, humbly to beg your Countenance and Assistance, that the Stream of Learning may be a little diverted, in those Schools that are already erected, and to be instrumental for the erecting more, when they shall be wanting; that we may not be permitted still to begin at the wrong end; but that according to the practice of the Ancient Philosophers, Children may be instructed in *Arithmetick*, *Geometry*, *Musick* and *Astronomy*; before the Latine and Greek

Grammars are thought on, these Arts in themselves, are much more easie to be learned, tend more to a general good, and will in a great measure facilitate the Learning of the Tongues, to as many as shall after this Foundation laid, be continued at School, and provided for in either Universities. Your Honour was instrumental to enlarge the Maintenance for God's Minister in the Place where I live, and perhaps it may please God to make you so, not only in making this Place in particular, but many other Places in this Land happy, by procuring Schools for these Sciences, and not only so, but by your Loyal and Prudent managing the several Trusts committed to you, you may do much for God's Glory, your Countries Good, and the continuance of your own Honour to all Future Generations, which is, and shall be the Prayer of,

Your Honour's Obliged and

Devoted Servant,

JOHN NEWTON.

TO THE

READER.

MY *Design in publishing these Introductions to* Geometry *and* Astronomy, *is so well known by all the Epistles, to my other Treatises of* Grammar, Arithmetick, Rhetorick, *and* Logick, *that I think it needless to tell thee here, that it is my Opinion, that all the Arts should be taught our Children in the English Tongue, before they begin to learn the Greek or Latin Grammar, by which means many thousands of Children would be fitted for all Trades, enabled to earn their own Livings, and made useful in the Commonwealth; and that before they attain to twelve years of age; and by consequence the swarming of Bees would be prevented, who being compelled to leave their Hives, for want of room, do spread themselves abroad, and instead of gathering of Honey, do sting all that come in their way. We should not have such innumerable company of Gown-men to the loss and prejudice of themselves and the Commonwealth; and those we had would probably be more learned, and better regarded.*

His

To the Reader.

His Majesty being pleased to begin this Work, by His Bounty towards a Mathematical School in Christ's *Church* London; *I am not now without hopes, to see the same effected in many other Places in this Kingdom; and to this purpose I have to my Introductions to the other Arts, added these also to* Geometry *and* Astronomy; *which I call by the name of* Cosmographia; *and this I have divided into four Parts; in the first I have briefly laid down the first Principles belonging to the three kinds of Magnitude or continued Quantity, Lines, Planes and Solids; which ought in some measure to be known, before we enter upon* Astronomy, *and this part I call an Introduction unto* Geometry.

The second and third Parts treat of Astronomy; *the first of which sheweth the Doctrine of the* Primum Mobile, *that is, the Declination, Right Ascension, and Oblique Ascensions of the Sun and Stars, and such other Problems, as do depend upon the Doctrine of Spherical Triangles.*

The second Part of Astronomy, *treateth of the motion of the Sun, Moon and Fixed Stars; in order whereunto, I have first given thee a brief account of the Civil Year, with the cause of the difference between our* Julian *and* Gregorian Calendar, *and of both from the true; for it must be acknowledged*

that

that both are erroneous, though ours be the worse of the two; yet not so bad, but that our Dissenting Brethren have I hope some better Arguments to justifie their Non-conformity, than what I see published in a little Book without any name to it, concerning two Easters in one Year; by the General Table, saith this learned man, who owneth the Feast of Easter was to be observed Anno 1674. *upon the* 19 *day of* April, *so the Almanacks for that Year, as well as the General Table set before the Book of Common Prayer; but by the Rule in the said Book of Common Prayer given, the Feast of Easter should have been upon the twelfth of* April, for Easter-Day must always be the first Sunday after the first Full Moon, which happeneth next after the one and twentieth day of *March*, and if the Full Moon happen upon a Sunday, Easter-Day is the Sunday after; *Now in the Year* 1674. *the* 19 *of* April *being Friday was Full Moon, therefore by this Rule, Easter-Day should be the twelfth, and by the Table and the Common Almanacks* April *the tenth; but this learned man must know, that the mistake is in himself, and not in the Rule or Table set down in the Book of Common Prayer; for if he please to look into the Calendar, he will find that the Golden Number Three, (which was the Golden Number for that Year) is placed*

placed against the last day of March, *and therefore according to the supposed motion of the Moon, that Day was New Moon; and then the Full Moon will fall upon the fourteenth day of* April, *and not upon the tenth, and so by consequence the Sunday following the first Full Moon after the* 21 *day of* March *was the nineteenth of* April *and not the twelfth. And thus the Rule and the Table in the Book of Common Prayer for finding the Feast of Easter are reconciled; and when Authority shall think fit, the Calendar may be corrected and all the moveable Feasts be observed upon the days and times at first appointed; but till that be, a greater difference than one Week will be found in the Feast of Easter between the Observation thereof according to the Moons true motion, and that upon which the Tables are grounded; for by the Fathers of the* Nicene *Council it was appointed, that the Feast of Easter should be observed upon the Sunday following the first Full Moon after the Vernal Equinox, which then indeed was the* 21 *of* March; *but now the tenth, and in the Year* 1674. *Wednesday the* 11 *of* March *was Full Moon, and therefore by this Rule, Easter-Day should have been upon* March *the fifteenth, whereas according to the Rules we go by, it was not till* April *the nineteenth.*

The

The Tables of the Sun and Moons middle motions are neither made according to the usual Sexagenary Forms, nor according to the usual Degrees of a Circle and Decimal Parts, but according to a Circle divided into 100 *Degrees and Parts, and this I thought good to do, to give the World a taste of the excellency of Decimal Numbers, which if a Canon of Sines and Tangents were fitted to it, would be found much better, as to the computing the Places of the Planets; but as to the* Primum Mobile, *by reason of the general dividing a Circle into* 360 *Degrees, I should think such a Canon with the Decimal Parts most convenient, and in some cases the common Sexagenary Canon may be very useful, and indeed should wish and shall endeavour to have all printed together, one Table of Logarithms will serve them all, and two such Canons, one for the Study and another for the Pocket, would be sufficient for all Mathematical Books in that kind; and then men may use them all or either of them as they shall have occasion, or as every one is perswaded in his own mind.*

What I have done in this particular, as it was for mine own satisfaction, so I am apt to believe, that it will be pleasing to many others; and although I shall leave every one to abound in his own sense, yet I cannot think

that

that Custom ſhould be ſuch a Tyrant, as to force us always to uſe the Sexagenary form, if ſo, I wonder that men did not always uſe the natural Canon; if no alteration may be admitted, what reaſon can be given for the uſe of Logarithms; and if that be found more ready than the natural, in things of this kind, where none but particular Students are concerned, I ſhould think it reaſonable, to reduce all things hereafter, into that form, which ſhall be found moſt ready and exact; now the Part Proportional in the Artificial Sines and Tangents in the three firſt Degrees cannot be well taken by the common difference, and the way of finding them otherwiſe will not be ſo eaſie in the Sexagenary Canon, as in either of the other, and this me thinks, ſhould render that Canon which divides each Degree into 100 *Parts more acceptable; but thus to retain the uſe of Sines, Degrees, and Decimal Parts, doth not to me ſeem convenient, and to reckon up, a Planets middle motion, by whole Circles will ſometimes cauſe a Diviſion of Degrees by* 60, *which hath ſome trouble in it alſo, but if a Circle be divided into* 100 *Degrees, this inconvenience is avoided, and were there no other reaſon to be given, this me thinks ſhould make ſuch a Canon to be deſirable, but till I can find an opportunity of publiſhing ſuch an one, I ſhall forbear to*

ſhew

shew any further uses of it, and for what is wanting here in this subject, I therefore refer thee to Mr. Street's Astronomia Carolina, *and the several Books written in English by Mr.* Wing.

The fourth Part of this Treatise is an Introduction unto Geography, *in which I have given general Directions, for the understanding how the habitable part of the World is divided in respect of Longitude and Latitude in respect of Climes and Parallels with such other Particulars as will be found useful unto such as shall be willing to understand History; in which three things are required; The time when, and this depends upon* Astronomy; *the place where, and this depends upon* Geography; *and the Person by whom any memorable Act was done, and this must be had from the Historical narration thereof; and he that reads History without some knowledge in* Astronomy *and* Geography *will find himself at a loss, and be able to give but a lame account of what he reads; but after the learning of these Arts of* Grammar, (*I mean so much thereof, as tends to the understanding of every ones Native Language*) Arithmetick, Geometry *and* Astronomy; *a Child may proceed profitably to* Rhetorick *and* Logick, *the reading of History, and the learning of the Tongues; and sure there is no*

no ſtudious and ingenious man, but will ſtand in need of ſome Recreation, and therefore if Muſick *in the Worſhip and Service of God be not Argument enough to allow that a place among the Arts, let that poor end of Delight and Pleaſure be her Advocate; and although that all men have not Voyces, yet I can hardly believe, that he expects any Melodious Harmony in Heaven, that will not allow Inſtrumental Muſick a place on Earth; and as for thoſe that have Voyces, ſurely the time of learning Vocal Muſick, muſt be in Youth, and I am perſwaded that the Arts and Sciences to ſome good degree may be learned by Children before they be full twelve years old, and would our Grammar Maſters leave off their horrible ſeverity, and apply themſelves to ſuch ways of teaching Youth, as the World is not now unacquainted with, I am perſwaded that it is no difficult matter, in four years time more to fit Children in ſome good meaſure for the Univerſity.*

The great Obſtruction in this Work, is the general Ignorance of Teachers, who being unacquainted with this Learning, cannot teach others what they know not themſelves. I could propound a remedy for this, Sed Cynthius aurem vellit; *Therefore I will forbear and leave what I have written, to be peruſed and cenſured as thou ſhall think fit.*

John Newton.

THE
Preface to the Reader.

Reader,

IN this curious aud useful Book you will find so many things necessary to be known, and put in Practice, that I am constrained to say none, tho' in a larger Volumn, ever produced the like Satisfaction to mankind. It treats of such Arts and Sciences, that conduce mainly to perfect the Understanding, and are indeed the most advantageous Parts of Learning, giving a Lustre and Ornament to an Accomplish'd mind; and in Trade, and matters of great moment are so very necessar, that those who are destitute of such a help on Emergencies, will plainly find many Losses, Obstructions and Disappointments in the nicest Dealings, and Things, by such a Defect. You have here, if well learn'd and put in practice, a plentiful Stock of Ingenuity, to set up with in the World, and render you capable of weighty Affairs, which by this means, well managed, will redound to your Credit and Profit, so that I may properly term it an Estate to him who is possessed of so much Knowledge as this Treatise can furnish him withal. Many indeed have essayed to Midwife the like into the World, but they have mostly proved Abortive; and those that have come to light, for want of great Pains and Care in bringing them forth, have appear'd Lame and Decrepit, not answering the Expectations many were too forward to conceive of them; however, some few have not fail'd to give an indifferent satisfaction, and the rather, as I am induced to believe, because no better appeared to displace them in their Opinions.

I have for the better Eaſe of the Reader divided the ſeveral Subjects treated on in this laboured Work, into four parts. The firſt I begin with is the curious and neceſſary Art of Dialing, giving an Inſight for the poſiting and framing Sun Dials, in a true and exact way, To ſhow the Hours of the Day in the Minuteſt Point, aod to proceed to Geometry *in its Principles belonging to the three kinds of Magnitude, or contained Quantity, Lines, Planes and Solids, ſo neceſſary to be known by thoſe that are deſirous to enter on* Aſtronomy.

The ſecond and third Parts treat of the moſt ingenious and uſeful Art of Aſtronomy; *the firſt demonſtrably laying down the Doctrine of the* Primum Mobile, *or firſt and great Mover of the Spheres in the Declination, right, and oblique Aſcenſion of the Sun and Stars, and ſuch other Problems and curious Matters nicely handled, as depend on the Doctrine of* Spherical Triangles, *&c. Alſo of the ſecond part of* Aſtronomy, *which treateth of the Motions of the Sun, fixed Stars, and Moon. In order to the better underſtanding of which, I have thought it convenient not to omit a ſatisfactory Account of the Civil Year, and the reaſon of the Variation or Difference between the* Gregorian *and* Julian *Accounts in the ſeveral Calendars, and of both from the True; having ſet every thing to rights, that in either of them are found out of Frame and Order, diſcovering and correcting what is erroneous.*

As for the fourth and cloſing part of this Laboured Work it contains a compleat Body of Geography, *giving an Account of the Countrys ſeated in the four quarters of the World,* viz. Europe, Aſia, Africa *and* America, *wonderfully conducing to the Advantage of Travellers, becauſe I have withal given the Longitude and Latitude; ſo dividing the Globe, that they may know in what Degrees they are, tho never ſo remote. I alſo therein have had reſpect to the Climes and Parallels with ſuch other Particulars,*

culars, as will be very helpful to further those that read History to a true Understanding of it; for I dare presume to affirm, that such as are ignorant of Astronomy *and* Geography, *whatever they may pretend, must needs be at a loss, and give but a very lame Account of History; especially, reading the Affairs of foreign Nations For on* Astronomy *depends the time when the things were transacted, and on* Geography *the place where; History only giving a Narration of the Persons and Actions. These likewise lead to other Arts of Rhetorick, Logick, and enable the Mind more freely to comprehend great things, improving the Memory, and raising Ideas in the Fancy and Imagination, to prompt Persons to undertake, and carry on Matters of mighty moment, and that they may not be ignorant of the sparkling Seeds of Light, that stud the Azure Firmament with Glittering Brightness, I have concluded with a Catalogue of some of the most notable Fixed Stars, giving their Names and Positions in the several Signs and other parts of the spacious Skies, from the Artick to the Antartick Pole, rectifying therein the Mistakes of many who have wrong placed them, or taken one for another, and so made Disorder by their Errors, and lead others into the like Entanglements.*

To be brief, there is nothing relating to these Matters (which in a Preface can be expected, only to be lightly touched on) but is so orderly discussed, that the largest Capacity can reasonably desire no more, and the meanest with little Labour may easily understand them, and improve by Diligence to a great degree; not only in these Arts, but by them be enabled to comprehend others, and reach a considerable way towards a Universal Knowledge, or so much as may be sufficient to render a good Proficiency, and rare Accomplishment; which are things very desirable to all Men, particularly to generous Spirits, who labour to improve,

that

that so they may be capable to impart their Talents to the Profit of the Publick; for the Wise must confess they were not born for themselves only, but for God's Honour, the Benefit of their Country, and lastly for themselves. This rightly stated and consider'd, is Heroick Virtue, well becoming noble Souls, who are desirous to have their Names outlast the Marble Monuments of Princes, and their Fame keep equal Pace with Time, till it shall be Ingulfed in round Eternity.

I might add much more in Commendation of so Laboured and Useful a Work; but least I should be taxed by some with too much Conceit of this Offspring of my Brain, if Modesty check'd me not, it might be a Motive sufficient to make me desist from a further Encomium on Subjects that can never be sufficiently praised; and therefore leaving the Book to plead its own Merits, I humbly crave Leave to subscribe my self,

Reader,

Your Friend and Servant,

H. Calton

The

James Burgess Vade Mecum

The Curious Art of Dialing *in all its useful Particulars, relating to the several kind of* Dials *in use; with General Instructions how exactly to draw the Lines and Figures, rightly to place them,* &c.

The Advantage of this Art of Flat Dials, *and what is required in the true Placing, Ordering,* &c.

THE Ingenious Art of Dialing now brought to the height of Perfection, is highly commendable; for what can be more curious than the making a Shadow divide the Day, and measure Time with the Sun's Motition, yet to do this exactly much Skill is requir'd, the Artist must be a Proficient in Numbers, and understand the Sun's Height and Declination, to make every thing bear well in due Proportion, that he may so place his Dial; that there may be no material Variation in that Glorious Planet of the Days coming up to the Tropick of *Cancer*; or the Summer Solstice, or its Retrograding to the Tropick of *Capricorn*, or the Winter Solstice; for these two are its Boundaries on this side, and beyond the Equinoctial Line. The Horizon must likewise be considered as the Place is posited in North or South Latitude, and the Degrees exactly found out, and then a great Light is gain'd, to shew you the way truly, to divide the Hours of the Day. But to come nearer to the Purpose; in all Flat Dials, placed against Walls, or otherwise in Planes, observe that the Stile or streight Wyre that

that ſhadows every Hour-Line, muſt point directly to each of the Two Stars, like as the dated Line; which if you can place upon any upright or flat thing, you may with eaſe draw the Hour-Line by the ſhadow thereof at length by another Sun-Dial rightly placed, when the ſhining of the Sun, gives a full ſhadow, or for want of that Opportunity, it may be done by a true-ſet Clock, or Watch, as thus.

If the Stile be to be placed on an upright Wall, directly ſtanding to a South-Sun, immediately when the Clock or Watch makes the twelfth Hour, ſet one end of a Staff for that purpoſe againſt the Wall, and at the other end faſten a Line with a Plummet at the end of it, hanging perpendicular, and ſo let it continue without any moving, till the ſhadow of the Staff and Line make but one, being held ſquarewiſe; then exactly mark both ends of the ſhadow, upon which place your Stile without Variation from that ſhadow, that the diſtance of the lower end from the Wall may be Thirty-ſeven Degrees, three Minutes; and draw the Hour-Lines as before; and when the Days are at the longeſt, add more Hour-Lines, and obſerve that you ſet the Stile Squarewiſe from the Wall.

To make a Sun-Dial on a Ceiling in a Chamber or Banqueting Houſe, &c.

This is very convenient if the Windows truly anſwer the Sun; and if ſo, may be made for all Hours if the place where it is to be fixed takes the Sun's Aſcendant and Declination; however, let it be what it will, it may be advantageous to ſuch as are ſick, or have Buſineſs within Doors, to know how the Time paſſes.

To contrive and fix this, let the Ceiling of the Room be very even and tight, becauſe the Sun-beams cannot ſhine direct on the Ceiling, the Rays or Light muſt be carry'd by Reflexion; and therefore let ſome true Looking-Glaſs, or other bright Mirror be fixed in ſome Tranſome of the VVindow, or other convenient

convenient Place, where it may give a true Reflexion, lying exactly paralel to the Horizon; let it be immoveably fixed with Glue or Tin, with a hole before the Glass, nail'd fast, to keep it down; for if by any Accident it be varied or stirr'd from its place, it cannot without much difficulty be set right again, for the last Hour-lines; or this may be done with a Bason of Water that will give a clear Reflexion, but it must be firmly fixed as the other.

Thus having order'd Matters, mark on the Ceiling for the Hour-lines, by the Help and Direction of another Sun-dial, once a Week, till you have well consider'd the Motion of the Sun in it Declination and Ascendant. Then draw the Lines over the Marks for each Hour-line, and figure them at the end of each Line for the Hour; so draw black Lines on the sides of the Dial, which may be done with little charge with black Earth, Lamp-black, and Gum-water; and if it goes not true at first, vary the Lines till you find the reflected Light answer the true Hour of the Day.

To know by this Dial when the Days and Nights are equal, or longest and shortest.

To do this make marks by the shadow on the Lines on the 10th of *March*, and 10th of *September*, and these will give you the Equality of Day and Night; then for the longest and shortest Days make marks with some Variation or Distinction from the other on the 11th of *June*, the longest Day, and the 11th of *December*, the shortest Day, and these will show you, and be satisfactory to your Curiosity; this may be likewise done on other Dials abroad, either on plain Walls, or on Board.

Boards how to prepare for Dials.

One great matter in having a Dial go true, if on a Board, is to prepare the Board well season'd and dry'd, that it may not warp nor crack; and for all this it must be armed against the Weather, to make it more lasting.

To do this, put an ounce of Litharge of Gold to a

pint of Linseed-oyl; set them in a glazed earthen Vessel over a gentle Fire till they almost boyl; stir them often, and when they are well mixed, grind half a pound of Red-lead on a Marble or Porphery-stone with a Muller; do it with Linseed-oyl to moisten it, till it becomes very fine, as soft as Flower, without any grits in it; mix it then with the Oyl & Litharge, stirring it till well incorporated; with this prime the Dial board with a fine hair Brush; let it dry in the shade, and so do it over twice more, letting it dry successively; and when it has well soaked the Wood, grind white Lead as the former, and mix it with Linseed-oyl only, and lay the Red finely over with this, but so, that none of the Red may appear; and for the Hour-lines, Figures or Letters, work Linseed-oyl with Lamp-black on a Stone till it is finely incorporated, and glistens; then draw them according to Art; but if you would have Golden Letters & Figures, take white Lead and yellow Oaker, grind them with Linseed-oyl finely as the former; draw the Figures or Letters with it, and about 12 Hours after press on Leaf Gold with Cotton Wool, that it may stick well; but be sure it is smoothly laid, without ruckling, and when dried on, dust off the Fragments, when to make the edges even, or seemly shadow them with a suitable Colour, to smooth and proportion them.

To make and well place a direct East *and* West *Dial.*

First draw the Horizontal Line of the Plane from East to West exactly in the middle, and let the Substilar Line point at both ends to the two Figures of 6, which make 6 in the Morning, and 6 in the Afternoon, and make an Angle therewith equal to the Latitude of the place at 52 degrees, 30 minutes, so that it may point exactly at the Artick and Antartick Poles; then draw another Line at right Angles to the 6 of Clock Line, and next, as a Center, let a Circle be described, whose *Radius* shall be equal to the height of the Stile, which prick off, and after that, intersect the Line in the Point, where make a prick for a 7 a Clock Line; then lay your Ruler again, and you will

will find it to cut the Line for the 8 of Clock-line, and so mark out the rest, drawing the Lines to the variation of the Sun, by marking the due Proportion of Distance by your Compass before you draw them, so as to stand for the Hour-lines, and so to 9, 10, 11, +, then for every of the said Points so drawn draw Lines paralel to the Substile or Hour of the Line of 6, and you shall have 6, and you shall by that means have six of the Hour-Lines intersected.

Lastly, make the Hour-lines of 5 and 4 in the Morning as far distant from the Substile towards the Left Hand, as the Lines of 7 and 8 are towards the Right Hand, always remembring to place the *Gnomen* directly over the Line, pointing from 6 to 6, and by a little Observation you may perfect it to your wish.

How to direct East *and* West *Dials.*

As for the Stile place it as has been directed in the foregoing, by setting the Board Southward by a Wall, to find the exact place where it should stand by the help of a Stick and Plummet; then take it away when you have fastned the Stile, and it will be in a right Dimension.

If you are to make a Post-Dial, take 52 degrees, 30 minutes, the rest, or other part of the Quadrant, for the height of the Stile being about 53 Degrees, or something under, set the Stile upright, that the shadow may Center in it exactly South and North when the Sun makes it 12 of the Clock, and draw the Hour-Lines as before.

To make a Horizontal, or plain lying Dial.

This may be drawn on a very even piece of Lead or Brass with engraving; but the Lines must first be measured out with the compass. To begin, mark out, and draw the Meridian-Line in the middle square wise to the Dial, being 12 of the Clock. Then at right Angles draw the 6 a Clock Line from East to West, even in the middle, thro' the Center, upon which Center make a Quadrant of any Circle to the

out Line Eastward of the Dial, and divide it unto 90 degrees, and the Elevation of the Pole shall be accounted unto it, which in this Example is 52 degrees, which take off for the height of the Stile; then draw the Line call'd the Line of Contingency, squarewise, and so measure with your Compass the least Distance, and with that extent describe the half Circle, which divide into 12 equal Parts; this done, lay your Ruler on the Center, and upon every Mark or Division made in the half Equator; and where the Rule shall touch the Line of Contingency, there mark to draw the Lines for the Hours at their Distances according as you have observ'd the Sun make its shadow, when the Hours strike by a true-going Clock; and for the Hours 7 and 8 draw the same distance on both sides the Center-Line above and below only; for 7 and 8 on the East side, and 4 and 5 on the West side; and note, That the distance between 1 and 12 must not vary from the distance between 12 and 11; and as between 11 and 10, so it must be between 1 and 2, and by this Rule proportion the distance of the rest of the Hours.

To make a South erect direct Dial.

This in ordering varys not much from the former, for the making of it is almost altogether like unto the Horizontal; but note also by the way that the Stile of the Horizontal Dial was to be 52 deg. and the Stile of this must be the rest of the Quadrant, that is 38 deg. and further, by the way of advice it will not be amiss to draw this and other kind of Dials of this nature on clean Paper or Parchment, then with the help of your Compasses placed on the Plat or Plane where you intend it; so that if there should be any error, it may be the easilier rectified, and this way you may draw by another Dial more exactly.

To make a South erect Dial in the Latitude of 50 Degrees Declination of the Plain 50 Degrees.

Note, That in every declining Dial, because that the Stile hangs not directly over the Meridian-line, your care is first to find out, and place the Substile (which is the

theLine over which the Stile ſhould directly hang) as like wiſe theLine of the Stile, and to this purpoſe obſerve, *Firſt*, by the Inſtrument or Board ſeek out the Declination or Plain, whereon you would fix your Dial; which ſuppoſe you find to be 50 deg. then draw the Horizontal Line, and let the Meridian Line cut it ſquarewiſe, cutting the Meridian in what part you think fit on the Center moſt properly deſcribe the Quadrant of a Circle, dividing into 90 deg. and let theElevation of theEquator be 38 deg. then lay your Ruler upon the Center, which is the Line paſſing in the middle from the Zenith to the Nadiz, and upon the end of this number draw the Line from Eaſt to Weſt; then again account the Quadrant from juſt under that Line towards the upper corner Eaſt, the Declination of the Plat being 50 deg. and draw the Line of Declination a little below that corner to the Eaſt end of the Line, running thro' the center, and from thence to the 50 deg. then ſet one foot of the Compaſs juſt under the Center-Line in the middle of it, and extend the other to the Eaſt end of the Line, a little above it; then turn one Foot to the top of the Dial, juſt againſt the direct Line, and removing the other, decline it to the Eaſt part; and ſo placing your Stile exact thro' the Center, take the equal diſtance of the Hour-figures, and fix the Dial ſo that it may not be ſhaken or varied by Wind or any other Accident, and you have a true South erect declining Dial.

Of Dialing in general; and firſt to find the Elevation of the Meridian Line above the Horizon.

As for the Meridian Line it is either paralel to the Horizon, or elevated the one end higher than the other; and where there is either Horizontal, or Eaſt or Weſt, and either reclining or inclining, the Meridian is paralel to the Horizon: But in all other Flats that diſagree from the Plain of the Meridian Circle, the Meridian Line is elevated one end higher than the other. This Elevation is either upright, as in all erectDials, not declining 90 deg. or elſe leaning, as in

all inclining and reclining Flats not declining 90 deg. which if they be erect, is equal to the Complement of Reclination or Inclination.

If the Meridian Line be not erect, it leaneth either Northward, when the elevated end looketh towards the North, or else Southward, when the elevated end looketh towards the South.

All Flats are either Polars, which being continu'd without going by the Poles of the World, as all leaning Flats, wherein the Elevation of the Meridian Line is Northwards, and equal to the Poles Elevation, and all erect Decliners 90 deg. otherwise they are no Polar Flats.

What Hour Lines are to be expressed in all sort of Dials.

In all Dials those Hour lines are only to be expressed; on which the shadow upon which the shadow of the Stile shall fall, and consequently therefore only the Hours of the Day.

In Dials not Polar, wherein the height of the Stile is not augmented, if the Stile point upwards, and the Elevation from the Substilar Line be not less than the Complement of the Sun's greatest Declination, all the Hour lines serving for the longest day are to be expressed therein. But if the Elevation of the Stile from the Substilar be less than the Complement of the Sun's greatest Declination, draw a right Line out of the Intersection of the Line of Contingence and Substilar, perpendicularly overtwhart the Stilar Line, placing one Foot of your Compass in the Center of the Dial, and extending the other towards the other end of the Stiler Line, therefore draw an Arch equal to the Complement of the Sun's greatest Declination, and thereby draw a Line out of the Center of the Dial, setting one Foot of your Compass in the Intersection of this Line with the mention'd Perpendicular, Extend the other Foot to the Stilar Line; then keep this distance, set one Foot of your Compass in the center of the Equinoctial Circle, and with the other cross the Line of Contingence on both sides the Substilar;

and

and now if you lay your Ruler to these Crosses, and the Center of the Dial, right Lines drawn thereby beyond the center of the Dial will continue between them the space wherein no Hour lines are to be expressed.

This Rule is certain also in Meridianal Dials, inclining, when the Elevation of the Stile is counted from the upper end of the Meridian Line, and the Elevation of the Stile from the Substiler, is less than the Complement of the Sun's greatest Declination.

If the Stile point downwards, no Hour lines are to be expressed above the Line paralel to the Horizon, drawn to the center of the Dial; and if in the cross in the Line of Contingency be above the Line, equidistant to the Horizon, drawn by the Center of the Dial, no Hour lines are to be expressed above a right Line, drawn from the Cross, and continued beyond the Center of the Dial, if any part of the Dial whereon the shadow of the Stile may full be destitute of Hour lines; let the Hour lines be continued forth unto that part of the Dial.

What Numbers must be set to the Hour-Lines.

In Meridianal Dials the Substilar Line is that of the Sixth Hour; but for the rest it must be considered whither it be an Oriental or Accidental Dial; the first of these direct to the East, and require only the Forenoon-Hours; and therefore the Substilar Line sheweth 6 of the Clock in the Morning, from which, towards the North are the Morning Hours before 6, *viz.* 5, 4, 3, *&c* but towards the South 7, 8, 9, 10, 11. An accidental Dial looketh directly Westward, and only the Hours after Noon can be set in this Dial; therefore the Substilar Line sheweth the sixth Hour Afternoon; from which, towards the North are the Hours before 6 in this Order, 5, 4, 3, 2, 1. But towards the South, after 6 thus; 7, 8, 9. *&c.*

In Dials not Meridianal, if a Ruler be laid to the center of the Equinoctial, and the beginning of the Division thereof doth cross the Touch line, then the

the Hour line drawn by that crossing is the Line of 12 a Clock; but if it cannot cross the Touch line, imagine notwithstanding that crossing; and the 12 a Clock line drawn thereby, without the bounds of the Dial, whereabouts you imagine it would be if the Ruler and Touch line were continued forth long enough, then in all Dials not Meridianal imagine the Stile to be fastened in this place in Equinoctial Dials, perpendicular erected out of the Center. In Dials that are not Equinoctial imagine it to be placed exactly over the Substilar Line so much raised from the same as the Stilar line is distant from the Substilar line in the Scheme of Paper or Pastboard you have drawn.

After this place that whereon the Figure of your Dial is described in the same Site or Position that the Dial-Ground is or must be placed; so that the Quarters of the World marked thereon, may answer in Position to the Quarters of the World, as they lie in respect of your Dial ground; for then if the 12 a Clock line be towards the North from the Stile, it is the Line of the twelfth hour of the Day; from hence therefore towards the West are the Forenoon Hours, 11, 10, 9, 8, 7, *&c.* and towards the East the Afternoon Hours, 1, 2, 3, 4, 5, 6, *&c.* But if the 12 a Clock Line be Southward from the Stile, it is the Line of the twelfth Hour in the Night; from hence therefore on both sides are the right Hours towards the West after Midnight, 1, 2, 3, 4, *&c.* towards the East, before Midnight, 11, 10, 9, 8, *&c.*

And thus much may suffice as an Introduction into the curious Art of Dialling, from whence I proceed to that of Geometry, and so to the rest I have proposed, in order.

Practical

James Burgess Geometry

Practical Geometry;

OR, THE

ART of SURVEYING.

CHAP. I.

Of the Definition and Division of Geometry.

GEometry is a Science explaining the kinds and properties of continued quantity or magnitude.

2. There are three Kinds or Species of Magnitude or continued Quantity, viz Lines, Superficies, and Solids.

3. A Line is a Magnitude consisting only of length without either breadth or thickness.

4. In a Line two things are to be considered, the Terms or Limits, and the several Kinds.

5. The term or limit of a Line is a Point.

6. A Point is an indivisible Sign in Magnitude which cannot be comprehended by sense, but must be conceived by the Mind.

7. The kinds of Lines are two, Right and Oblique.

8. A Right Line is that which lieth between his Points, without any going up or going down on either side. As the Line *AB* lieth streight and equally between the Points *A* and *B*. *Fig.* 1.

9. An Oblique Line is that which doth not lie equally between its Points, but goeth up and down sometimes on the one side and sometimes on the other. And this is either simple or various.

10. A simple Oblique Line, is that which is exactly Oblique, as the Arch of a Circle; of Various Oblique Lines there is but little use in Geometry.

11. Thus are Lines to be considered in themselves, they may be also considered as compared to one another, and that either in respect of their distances, or in respect of their meetings.

12. In respect of their distances, they may be either equally distant, or unequally.

13. Lines equally distant are two or more, which by an equal space are distant from one another, and these are called Parallels; and these though infinitely extended will never concur.

14. Lines unequally distant, are such as do more or less incline to one another, and these being extended will at last concur.

15. Concurring Lines are either perpendicular or not perpendicular.

16. A Perpendicular Line, is a Right Line falling directly upon another Right Line, not declining or inclining to one side more than another; as the Line *AB* in *Fig.* 1.

17. A Perpendicular Line is twofold, to wit, either falling exactly in the middle of another Line, or upon some other Point which is not the middle.

18. A Line exactly Perpendicular, may be drawn in the same manner, as any Right Line

may

may be divided into two equal Parts; the which may thus be done. If from the two Terms or Points of the Right Line given, there shall be described two Arches crossing one another above and below, a Line drawn through the Intersections of those Arches, shall be exactly Perpendicular, and also divide the Right Line given into her equal Parts. *Fig.* 1.

For Example; Let CD *be the Right Line given, and let it be required, to bisect this Line, and to erect a Perpendicular in the middle thereof.* 1. *Then setting one of your Compasses in the Point* C, *draw the Arches* E *and* F. 2. *Setting one Foot of your Compasses in* D, *draw the Arches* G *and* H, *and from the Intersections of these Arches draw the Right Line* K L, *so shall the Right Line* KL *be Perpendicular to the Right Line* CD, *and the Right Line* C D *also divided into two equal Parts, in the Point* A.

19. A Line Perpendicular to any other Point than the middle is twofold: for it is either drawn from some Point given in the Line; or from some Point given without the Line.

20. From a Point given in the Line, a Perpendicular may thus be drawn. *In Fig.* 2. *Let the given Line be* C D, *and let it be required to draw a Perpendicular Line to the Point* C, *your Compasses being opened to any reasonable distance, set one Foot in the Point* C, *and the other in any place on either side the Line* C D, *suppose at* A, *then describe the Arch* E C F, *this done draw the Line* E A, *and where that Line being extended shall cut the Arch* E C F, *a Right Line drawn from* C *to that Intersection shall be Perpendicular to the Point* C *in the Line* C D, *as was required.*

21. From a Point given without the Line, a Perpendicular may be drawn in this manner.

In Fig. 2. *Let the given Line be* C D, *and let it be required to draw another Line Perpendicular thereunto, from the Point* F *without the Line. From the Point* F *draw a ſtreight Line to ſome part of the Line* C D *at pleaſure, as* F E, *which being biſected, the Point of Biſection will be* A, *if therefore at the diſtance of* A F, *you draw the Arch* E C F, *the Right Line* C F *ſhall be Perpendicular to the Line* C D, *as was required.*

22. Hitherto concerning a Perpendicular Line. A Right Line not Perpendicular, is a Right Line falling indirectly upon another Right Line, inclining thereto on the one ſide more, and on the other leſs.

23. Lines unequally diſtant, and at laſt concurring, do by their meeting make an Angle.

24. An Angle therefore is nothing elſe, then the place, where two Lines do meet or touch one another, and the two Lines which conſtitute the Angle, are in Geometry called the ſides of the Angle.

25. Every Angle is either *Heterogeneous*, or *Homogeneous*: that is called an *Hetorogeneous* Angle, which is made by the meeting of one Right Line, and another that is Oblique and Crooked; and that is called an *Homogeneous* Angle, which is made by the meeting of two Lines of the ſame kind, that is, of two Right Lines, or of two curved or Circular Lines.

26. An *Homogeneous* Angle made of two curved or Circular Lines, is to be conſidered in Geometry as in Spherical Triangles, but the other which is made of Right Lines, is in all the Parts of Geometry of more frequent uſe.

27. Right lined Angles are either Right or Oblique.

28. A Right Angle is that whose legs or sides are Perpendicular to one another, making the comprehended space on both sides equal. *Thus in Fig.* 1. *the Line* AK *is Perpendicular to the Line* CD, *and the Angles* KAC *and* KAD, *are right and equal to one another.*

29. An Oblique Angle is that, whose sides are not Perpendicular to one another.

30. An Oblique Angle is either acute or obtuse.

31. An Acute Angle is that which is less than a Right.

32. An Obtuse Angle, is that which is greater than a Right. *Thus in Fig.* 1. *The Angle* BAC *is an Acute Angle because less than the Right Angle* CAK. *And the Angle* BAD *is an Obtuse Angle being greater than the Right Angle* DAK.

The Geometrical Propositions concerning Lines and Angles are very many, but these following we think sufficient for our present purpose.

Proposition I.

To divide a Right Line given into any Number of equal Parts.

Let it be required to divide the Right Line *AB* into five equal Parts. From the extream Points of the given Line *A* and *B*, let there be drawn two Parallel Lines, then from the Point *A* at any distance of the Compasses, set off as many equal Parts wanting one, as the given Line is to be divided into, which in our Example is four, and are noted thus, 1. 2. 3. 4. and from the Point *B* set off the like Parts in the Line *BC*, and let them be

noted likewise thus, 1. 2. 3. 4. then shall the Parallel Lines, 14. 23. 32. and 41. divide the Right Line *A B* into 5 equal Parts, as was required.

Proposition II.

Two Right Lines being given, to find a Mean propertional between them.

Fig 4

Let the two Right Lines given be *D B* and *C B*, which let be made into one Line as *C D*, which being bisected the Point of bisection is *A*, from which as from a Centre describe the Arch *C E D*, and from the Point *B* erect the Perpendicular *B E*, so shall *B E*, be the Mean proportional required; for, *B C*: *B E* : : *B E*: *B D*.

Proposition III.

Three Right Lines being given, to find a fourth proportional.

Let the three given Lines be *A B*. *B C*. and *A D*. *Fig*. 5. to which a fourth proportional is required: draw *A E* at any Acute Angle, to the Line *A D* in the Point *A*; and make *D E* parallel to *B C*, so shall *A E* be the fourth proportional required; for, *A B*: *B C* : : *A D*: *A E*.

Proposition IV.

Upon a Right Line given, to make a right-lined Angle, equal to an Angle given.

Let it be required upon the Line *C D* in *Fig*. 6. to

to make an Angle, equal to the Angle *D A E* in *Fig*. 5. From the Point *A* as a Center, at any extent of the Compasses describe the Arch *B G*, between the sides of the Angle given, and with the same extent describe the Arch *H L* from the Point *D*, and then make *H L* equal to *B G*, then draw the Line *D L*, so shall the Angle *C D L* be equal to the Angle *D A E* given, as was required.

CHAP. II.

Of Figures in the general, more particularly of a Circle and the affections thereof.

Hitherto we have spoken of the first kind of Magnitude, that is, of Lines, as they are considered of themselves, or amongst themselves.

2. The second kind of Magnitude is that which is made of Lines, that is, a Figure consisting of breadth as well as length, and this is otherwise called a Superficies.

3. And in a Superficies there are three things to be considered. 1. The Term or Limit. 2. The middle of the Term. 3. The Thing or Figure made by the Term or Limit.

4. The Term or Limit is that which comprehendeth and boundeth the Figure, it is commonly called the Perimeter or Circumference.

5. The Term of a Figure is either Simple or various.

6. A Simple Term is that which doth consist of a Simple Line, and is properly called a Cir-

cumference or Periphery: A Periphery therefore is the Term of a Circle or most Simple Figure.

7. A various Term is that which hath bending or crooked Lines, making Angles, and may therefore be called Angular.

8. The middle of Term is that which is the Center of the Figure; for every Figure, whether Triangular, Quadrangular, or Multangular, hath a Center as well as the Circular, differing in in this, that the Lines in a Circle drawn from the Center to the Circumference are all equal, but in other Figures they are not equal.

9. The Thing or Figure made by the Term or Limit, is all that *Area* or space which is included by the Term or Terms. *And here it is to be observed, that the Term of a Figure is one thing, and the Figure it self another; for Example, A Periphery is the Term of a Circle, but the Circle it self is not properly the Periphery, but all that* Area *or space which is included by the Periphery, for a Periphery is nothing but a Line, but the Circle is that which is included by that Line.*

10. As the Term of a Figure is either Simple or Various; so the Figure it self is either Simple and Round, or Various and Angular.

11. A Simple Figure is that which is contained by a Simple or Round Line, and is either a Circle or an Ellipsis.

12. A Circle therefore is such a Figure which is made by a Line so drawn into it self, as that it is every where equally distant from the middle or Center.

13. An *Ellipsis* is an oblong Circle.

14. In a Circle we are to consider the affections which are as it were the Parts or Sections thereof,

thereof, as they are made by the various applications of Right Lines.

15. And Right Lines may be applied unto a Circle, either by drawing them within, or without the Circle.

16. Right Lines inscribed within a Circle, are either such as do cut the Circle into two equal or unequal Parts, as the Diameter and lesser Chords, or such as do cut the Diameter and lesser Chords into two equal or unequal Parts, as the Right and versed Sines.

17. A Diameter is a Right Line drawn through the Center from one side of the Circumference to the other, and divideth the Circle into two equal Parts, *As in Fig. 7. The Right Line* GD *drawn through the Center* B *is the Diameter of the Circle* GEDL *dividing the same into the two equal Parts* GED, *and* GLD: *and this is also called the greatest Chord or Subtense.*

18. A Chord or Subtense is a Right Line inscribed in a Circle, dividing the same into two equal or unequal Parts; if it divide the Circle into two equal Parts, it is the same with the Diameter, but if it divide the Circle into two unequal Parts it is less than the Diameter, and is the Chord or Subtense of an Arch less than a Semi-circle, and also of an Arch greater than a Semi-circle. *As in the former Figure, the Right Line* C A K *divideth the Circle into two unequal Parts, and is the Chord or Subtense of the Arch* CDK, *less than a Semi-circle, and of the Arch* CGK *greater than a Semi-circle: and these are the Lines which divide the Circle into two equal or unequal Parts. And as they divide the Circle into two equal Parts, so do they also divide one another; The lesser Chords when they are divided by the*

the Diameter into two equal Parts, those Parts are called Right Sines, and the two Parts of the Diameter made by the intersection of the Chords are called versed Sines.

19. Sines are right or versed.

20. Right Sines are made by being besected, by the Diameter, and are twofold, *Sinus totus*, the whole Sine or Radius, and this is the one half of the Diameter, *as the Lines* BE *or* BD, *and all Lines drawn from the Center to the Circumference.*

21. *Sinus simpliter*, or the lesser Sines, are the one half of any Chord less than the Diameter, *as in the former Figure* CA *or* AK, *which are the equal Parts of the Chord* CAK, *are the Sines of the Arches* CD. *and* DK *less than a Quadrant, and also the Sines of* CEG *and* KLG *greater than a Quadrant.*

22. Versed Sines are the Segments of the Diameter, made by the Chords intersecting it, at Right Angles, *as* AD *is the versed Sine of* CD *or* DG *and the other Segment* AG *is the versed Sine of the Arch* CEG *or* KLG.

23. The Right Lines drawn without the Circle are two, the one touching the Circle, and is called a Tangent, and the other cutting the Circle, and is called a Secant.

24. A Tangent is a Right Line touching the Circle, and drawn perpendicular to the Diameter, and extended to the Secant.

25. A Secant is a Right Line drawn from the Center through the Circumference, and extended to the Tangent. As in the former Figure, the Right Line *DF* is the Tangent of the Arch *CD*, and the Right Line *BF* is the Secant of the same Arch *CD*.

Proposition

Proposition I.

The Arch of a Circle being given to describe the whole Periphery.

Let *ABC* be an Arch given, and let the Circumference of that Circle be required. Let there be three Points taken in the given Arch at pleasure, as *A*, *B*, *C*; open your Compasses to more than half the distance of *A*, *B*, and setting one Foot in *A* describe the Arch of a Circle, and the Compasses remaining at the same distance, setting one Foot in *B*, describe another Arch so as it may cut the former in two Points, suppose *G*, and *H*, and draw the Line *HG* towards that Part on which you suppose the Center of the Center of the Circle will fall.

In like manner, opening your Compasses to more than half your distance of *B*, *C*, describe two other Arches from the Points *E* and *C*, cutting each other in *E* and *F*, then draw the Line *EF* till it intersect the former Line *HG*, so shall the Point of Intersection be the Center of the Circumference or Circle required, as in *Fig.* may be seen.

Proposition II.

The Conjugate Diameters of an Ellipsis being given, to draw the Ellipsis.

Let the given Diameter in *Fig.* 24. be *LB* and *ED*, the greatest Diameter. *LB* being bisected in the Point of Bisection, erect the Perpendicular

AD,

AD. which let be half of the lesser Diameter *ED*, then open your Compasses to the extent of *AB*, and setting one Foot in *D*, with the other make a mark at *M* and *N* in the Diameter *BL*, then cutting a thred to the length of *BL*, fasten the thred with your Compasses in the Points *NM*, and with your Pen in the inside of the thred describe the Arch *BFKL*, so shall you describe the one half of the Ellipsis required, and turning the Thred on the other side of the Compasses, you may with your Pen in the like manner describe the other half of the Ellipsis *GBHL*.

CHAP. III.

Of Triangles.

Hitherto we have spoken of the most Simple Figure, a Circle. Come we now to those Figures that are Various or Angular.

2. And an Angular Figure is that which doth consist of three or more Angles.

3. An angular Figure consisting of three Angles, otherwise called a Triangle, is a Superficies or Figure comprehended by three Right Lines including three Angles.

4. A Triangle may be considered either in respect of its Sides, or of its Angles.

5. A Triangle in respect of its Sides, is either *Isopleuron*, *Isosceles*, or *Scalenum*.

6. An *Isopleuron* Triangle, is that which hath three equal sides. An *Isoscecles* hath two equal Sides. And a *Scalenum* hath all the three Sides unequal.

7. A Triangle in respect of its Angles is Right or Oblique.

8. A Right angled Triangle is that which hath one Right Angle and two Acute.

9. An Oblique angled Triangle, is either Acute or Obtuſe.

10. An Oblique acute angled Triangle, is that which hath all the three Angles Acute.

11. An Oblique obtuſe angled Triangle, is that which hath one Angle Obtuſe, and the other two Acute.

Propoſition I.

Upon a Right Line given to make an Iſopleuron *or an Equilateral Triangle.*

In *Fig.* 8. let it be required to make an Equilateral Triangle upon the Right Line *AB*. Open your Compaſſes to the extent of the Line given, and ſetting one Foot of your Compaſſes in *A*, make an Arch of a Circle above or beneath the Line given, then ſetting one Foot of your Compaſſes in *B*, they being full opened to the ſame extent, with the other foot draw another Arch of a Circle croſſing the former, and from the Interſection of thoſe Arches draw the Lines *AC* and *AB*, ſo ſhall the Triangle *ACB* be Equilateral as was deſired.

Propoſition II.

Upon a Right Line given to make an Iſoſceles *Triangle, or a Triangle having two Sides equal.*

In *Fig.* 8. let *AB* be the Right Line given, from the Points *A* and *B* as from two Centers, but at a leſſer extent of the Compaſſes than *AB*; if

if you would have *A B* the greatest Side, at a greater extent; if you would have it to be the least Side, describe two Arches cutting one another, as at *F*, and from the Intersection draw the Lines *AF*, and *F B*, so shall the Triangle *AF B* have two equal Sides, as was required.

Proposition 3.

To make a Scalenum *Triangle, or a Triangle, whose three Sides are unequal.*

In *Fig.* 9. let the three unequal Sides be *E F G* make *AB* equal to one of the given Lines, suppose *G*, and from *A* as a Center, at the extent of *E* describe the Arch of a Circle; in like manner from *B* at the extent of *F* describe another Arch intersecting the former, then shall the Right Lines *AC*. *CB* and *B A* comprehend a Triangle, whose three sides shall be unequal, as was required.

CHAP. IV.

Of Quadrangular and Multangular Figures.

WE have spoken of Triangles or Figures consisting of three Angles, come we now to those that have more Angles than three, as the *Quadrangle*, *Quinquangle*, *Sexangle*, *&c.*

2. A *Quadrangle* is a Figure or Superficies, which is bounded with four Right Lines.

3. A *Quadrangle* is either a *Parallelogram* or a *Trapezium*.

4. A *Parallelogram* is a *Quadrangle* whose opposite

site Sides are parallel having equal distances from one another in all Places.

5. A *Parallelogram* is either Right angled or Oblique.

6. A Right angled *Parallelogram*, is a *Quadrangle* whose four Angles are all Right, and is either Square or Oblong.

7. A Square *Parallelogram* doth consist of four equal Lines. The Parts of a Square are, the Sides of which the Square is made, and the Diagonal or Line drawn from one opposite Angle to another through the middle of the Square.

8. An Oblong is a Right angled *Parallelogram*, having two longer and two shorter Sides.

9. An Oblique angled *Parallelogram*, is that whose Angles are all Oblique, and is either a *Rhombus* or a *Rhomboides*.

10. A *Rhombus* is an Oblique angled and equilateral *Parallelogram*.

11. A *Rhomboides* is an Oblique angled and inequilateral *Parallelogram*.

12. A *Trapezium* is a *Quadrangular* Figure whose Sides are not all parallel; it is either Right angled or Oblique.

13. A Right angled *Trapezium* hath two opposite Sides parallel, but unequal, and the Side between them perpendicular.

14. An Oblique angled *Trapezium* is a *Quadrangle*, but not a *Parallelogram*, having at least two Angles Oblique, and none of the Sides parallel.

15. Thus much concerning *Quadrangles* or four sided Figures. Figures consisting of more than four Angles are almost infinite, but are reducible unto two sorts, Ordinate and Regular, or Inordinate and Irregular.

16. Or-

16. Ordinate and Regular *Polygons* are such, as are contained by equal Sides and Angles, as the *Pentagon, Hexagon,* and such like.

17. Inordinate or irregular *Polygons*, are such as are contained by unequal Sides and Angles. The construction of these Quadrangular and Multangular Figures is explained in the Propositions following.

Proposition I.

Upon a Right Line given to describe a Right angled Parallelogram, whether Square or Oblong.

In *Fig.* 10. let the given Line be *AB*, upon the Point *A* erect the Perpendicnlar *A D* equal to *A B* if you intend to make a Square, but longer or shorter, if you intend an oblong, and upon the Points *D* and *B* at the distance of *A B* and *A D* describe two Arches intersecting one another, and from the Intersection draw the Lines *E D* and *E B*, so shall the Right angled Figure *AE* be a Square, if *AB* and *A D* be equal, otherwise an Oblong, as was desired.

Proposition II.

To describe a Rhombus *or* Rhomboides.

In *Fig.* 11. To the Right Line *A B* draw the Line *A D* at any Acute Angle at pleasure, equal to *A B* if you intend a *Rhombus*, longer or shorter if you intend a *Rhomboides*, then upon your Compasses to the extent of *A D* and upon *B* as a Center describe an Arch; in like manner, at the extent of *A B* upon *D* as a Center describe another

other Arch intersecting the former, then draw the Lines *E D* and *E B*, so shall *AE* be the *Rhombus* or *Rhomboides*, as was required.

Proposition III.

Upon a Right Line given to make a Regular Pentagon, *or five sided Figure.*

In *Fig.* 12. Let the given Line be *AB*, upon A and *B* as two Centers describe the Circles *E B G H* and *C A G K*, then open your Compasses to the extent of *B C*, and making *G* the Center, describe the Arch *H A F K*, then draw the Lines *K F E* and *H F C*: so shall *A E* and *B C* be two sides of the *Pentagon* desired, and opening your Compasses to the extent of *A B*, upon *E* and *C* as two Centers describe two Arches intersecting one another, and from the Point of Intersection draw the Lines *E D* and *D C*, so shall the Figure *AB* and *D E* be the *Pentagon* required.

Proposition IV.

To make a Regular Pentagon *and* Decagon *in a given Circle.*

In *Fig.* 13. upon the Diameter *C A B* describe the Circle *C D B L*, from the Center *A* erect the Perpendicular *A D*, and let the Semidiameter *AC* be bisected, the Point of Bisection is *E*, set the distance *E D* from *E* to *G*, and draw the Line *G D*, which is the side of a *Pentagon*, and *A G* the side of a *Decagon* inscribed in the same Circle.

C Propo-

Propoſition V.

In a Circle given to deſcribe a Regular Hexagon.

The ſide of a *Hexagon* is equal to the *Radius* of a Circle, the *Radius* of a Circle therefore being ſix times applied to the Circumference, will give you ſix Points, to which Lines being drawn from Point to Point, will conſtitute a Regular *Hexagon*, as was deſired.

Propoſition VI.

In a Circle given to deſcribe a Regular Heptagon *or Figure conſiſting of ſeven equal ſides.*

The ſide of a *Heptagon* is equal to half the ſide of a Triangle inſcribed in a Circle, having therefore drawn an *Hexagon* in a Circle, the Chord Line ſubtending two ſides of the *Hexagon* lying together, is the ſide of a Triangle inſcribed in that Circle, and half that Chord applied ſeven times to the Circumference, will give ſeven Points, to which Lines being drawn from that Point, will conſtitute a Regular *Heptagon*, as in *Fig.* 14. is plainly ſhewed.

CHAP.

CHAP. V.

Of Solid Bodies.

HAving spoken of the two first kinds of Magnitude, Lines and Superficies, come we now to the third, a Body or Solid.

2. A Body or Solid is a Magnitude consisting of length, breadth and thickness.

3. A Solid is either regular or irregular.

4. That is called a regular Solid, whose Bases, Sides and Angles are equal and like.

5. And this either Simple or Compound.

6. A simple regular Solid, is that whith doth consist of one only kind of Superficies.

7. And this is either a Sphere or Globe, or a plain Body.

8. A Globe is a Solid included by one round and convex Superficies, in the middle whereof there is a Point, from whence all Lines drawn to the Circumference are equal.

9. A simple plain Solid, is that which doth consist of plain Superficies.

10. A plain Solid is either a Pyramid, a Prism, or a mixt Solid.

11. A Pyramid is a Solid, Figure or Body, contained by several Plains set upon one right lin'd Base, and meeting in one Point.

12. Of all the several sorts of Pyramids, there is but one that is Regular, to wit a *Tetrahedron*, or a Pyramid consisting of four regular or equilateral Triangles; the form whereof (as it may be cut in Pastboard) may be conceived by *Figure* 15.

13. A Priſm is a Solid contained by ſeveral Plains, of which thoſe two which are oppoſite, are equal, like and parallel, and all others are *Paralellogram*.

14. A Priſm is either a *Pentahedron*, a *Hexahedron*, or a *Polyhedron*.

15. A *Pentahedron* Priſm, is a Solid comprehended of five Sides, and the Baſe a Triangle, as *Fig*. 16.

16. An *Hexahedron* Priſm, is a Solid comprehended of ſix Sides, and the Baſe a *Quadrangle*, as *Fig*. 17.

17. An *Hexahedron* Priſm, is diſtinguiſhed into a *Parallelipipedon* and a *Trapezium*.

18. An *Hexahedron* Priſm called a *Trapezium* is a Solid, whoſe oppoſites Plains or Sides, are neither oppoſite nor equal.

19. A *Parallelipipedon* is either right angled or oblique.

20. A right angled *Parallelipipedon* is an *Hexahedron* Priſm, comprehended of right angled Plains or Sides; and it is either a Cube or an Oblong.

21. A Cube is a right angled *Parallelipipedon* comprehended of ſix equal Plains or Sides.

22. An Oblong *Parallelipipedon*, is an *Hexahedron* Priſm, comprehended by unequal Plains or Sides.

23. An Oblique angled *Parallelipipedon*, is an *Hexahedron* Priſm, comprehended of Oblique Sides.

24. A *Polyhedron* Priſm, is a Solid comprehended by more than ſix Sides, and hath a multangled Baſe, as a *Quincangle*, *Sexangle*, *&c*.

25. A regular compound or mixt Solid, is ſuch a Solid

a Solid as hath its Vertex in the Center, and the ſeveral Sides expoſed to view, and of this ſort there are only three; the *Octohedron*, the *Icoſahedron*, of both which the Baſe is a Triangle; and the *Dodecahedron*, whoſe Baſe is a *Quincangle*.

26. An *Octohedron* is a Solid Figure which is contained by eight equal and equilateral Triangles, as in *Fig*. 18.

27. An *Icoſahedron* is a Solid, which is contained by twenty equal and equilateral Triangles, as *Fig*. 19.

28. A *Dodecahedron* is a Solid, which is contained by twelve equal *Pentagons*, equilateral and equiangled, as in *Fig*. 20.

29. A regular compound Solid, is ſuch a Solid as is Comprehended both by plain and circular Superficies, and this is either a Cone or a Cylinder.

30. A Cone is a Pyramidical Body, whoſe Baſe is a Circle, or it may be called a round *Pyramis*, as *Fig*. 21.

31. A Cylinder is a round Column every where comprehended by equal Circles, as *Fig*. 22.

32. Irregular Solids are ſuch, which come not within theſe defined varieties, as Ovals, *Fruſtums* of Cones, Pyramids, and ſuch like.

And thus much concerning the deſcription of the ſeveral ſorts of continued Quantity, Lines, Plains and Solids; we will in the next place conſider the wayes and means by which the Dimentions of them may be taken and determined, and firſt we will ſhew the meaſuring of Lines.

CHAP. VI.

Of the Measuring of Lines both Right and Circular.

EVery Magnitude must be measured by some known kind of Measure ; as Lines by Lines, Superficies by Superficies, and Solids by Solids, as if I were to measure the breadth of a River, or height of a Turret, this must be done by a Right Line, which being applied to the breadth or height desired to be measured , shall shew the Perches, Feet or Inches, or by some other known measure the breadth or height desired : but if the quantity of some Field or Meadow, or any other Plain be desired, the number of square Perches must be enquired ; and lastly , in measuring of Solids, we must use the Cube of the measure used, that we discover the number of those Cubes that are contained in the Body or Solid to be measured. First, therefore we will speak of the several kinds of measure, and the making of such Instruments, by which the quantity of any Magnitude may be known.

2. Now for the measuring of Lines and Superficies, the Measures in use with us, are Inches, Feet, Yards, Ells and Perches.

3. An Inch is three Barley Corns in length, and is either divided into halves and quarters, which is amongst Artificers most usual , or into ten equal Parts , which is in measuring the most useful way of Division.

4. A Foot containeth twelve Inches in length, and is commonly so divided ; but as for such things as are to be measured by the Foot, it is far better

better for uſe, when divided into ten equal Parts, and each tenth into ten more.

5. A Yard containeth three Foot, and is commonly divided into halves and quarters, the which for the meaſuring of ſuch things as are uſually ſold in Shops doth well enough, but in the meaſuring of any Superficies, it were much better to be divided into 10 or 100 equal Parts.

6. An Ell containeth three Foot nine Inches, aud is uſually divided into halves and quarters, and needs not be otherwiſe divided, becauſe we have no uſe for this Meaſure, but in Shop Commodities.

7. A Pole or Perch cotaineth five Yards and an half, and hath been commonly divided into Feet and half Feet. Forty Poles in length do make one Furlong, and eight Furlongs in length do make an Engliſh Mile, and for theſe kinds of of lengths, a Chain containing four Pole, divided by Links of a Foot long, or a Chain of fifty Foot, or what other length you pleaſe, is well enough, but in the meaſuring of Land, in which the number of ſquare Perches is required; the Chain called Mr. *Gunters*, being four Pole in length divided into 100 Links, is not without juſt reaſon reputed the moſt uſeful.

8. The making of theſe ſeveral Meaſures is not difficult, a Foot may be made, by repeating an Inch upon a Ruler twelve times, a Yard is ~~eight~~ Foot, and ſo of the reſt; the Subdiviſion of a Foot or Inch into halves and quarters, may be performed by the ſeventeenth of the firſt, and into ten or any other Parts by the firſt Propoſition of the firſt Chapter, and all Scales of equal Parts, of what ſcantling you do deſire. And this I think three

think is as much as needs to be ſaid concerning the dividing of ſuch Inſtruments as are uſeful in the meaſuring Right Lines.

9. The next thing to be conſidered is the meaſuring of Circular Lines, or Perfect Circles.

10. And every Circle is ſuppoſed to be divided into 360 Parts called Degrees, every Degree into 60 Minutes, every Minute into 60 Seconds, and ſo forward this diviſion of the Circle into 360 Parts is generally retained, but the Subdiviſion of thoſe Parts, ſome would have be thus and 100, but as to our preſent purpoſe either may be uſed, moſt Inſtruments not exceeding the fourth part of a Degree.

11. Now then a Circle may be divided into 360 Parts in this manner; Having drawn a Diameter through the Center of the Circle dividing the Circle into two equal Parts, croſs that Diameter with another at Right Angles through the Center of the Circle alſo, ſo ſhall the Circle be divided into four equal Parts or Quadrants, each Quadrant containing 90 Degrees, as in *Fig.* 7. *GE. ED. DL* and *LG*, are each of them 90 Degrees; and the *Radius* of a Circle being equal to the Chord of the ſixth Part thereof, that is to the Chord of 60 Degrees, as in *Fig.* 14. if you ſet the *Radius GB* from *L* towards *G*, and alſo from *G* towards *L*, the Quadrant *GL* will be ſubdivided into three equal Parts, each Part containing 30 Degrees, *GM.* 30. *MH* 30 and *HL* 30, the like may be done in the other Quadrants alſo; ſo will the whole Circle be divided into twelve Parts, each Part containing 30 Degrees.

And becauſe the ſide of a *Pentagon* inſcribed in a Circle is equal to the Chord of 72 Degrees, or the

the ~~firſt~~ fifth Part of 360, as in *Fig.* 13. therefore if you ſet the Chord of the firſt Part of the Circle given from *G* to *L* or *L* to *G*, in *Fig.* 7. you will have the Chord of 72 Degrees, and the difference between *G P* 72 and *G H* 60 is *H P* 12, which being biſected, will give the Arch of 6 Degrees, and the half of ſix will give three, and ſo the Circle will be divided into 120 Parts, each Part containing three Degrees, to which the Chord Line being divided into three Parts, the Arch by thoſe equal Diviſions may be alſo divided, and ſo the whole Circle will be divided into 360, as was deſired.

12. A Circle being thus divided into 360 Parts, the Lines of Chords, Sines, Tangents and Secants, are ſo eaſily made (if what hath been ſaid of them in the Second Chapter be but conſidered) that I think it needleſs to ſay any more concerning their Conſtruction, but ſhall rather proceed unto their Uſe.

13. And the uſe of theſe Lines and other Lines of equal Parts we will now ſhew in circular and right lined Figures; and firſt in the meaſuring of a Circle and Circular Figures.

CHAP.

CHAP. VII.

Of the Measuring of a Circle.

THE ſquaring of a Circle, or the finding of a Square exactly equal to a Circle given, is that which many have endeavoured, but none as yet have attained: Yet *Archimedes* that Famous Mathematician hath ſufficiently proved, That the *Area* of a Circle is equal to a Rectangle made of the *Radius* and half the Circumference: Or thus, The *Area* of a Circle is equal to a Rectangle made of the Diameter and the fourth part of the Circumference. For Example, let the Diameter of a Circle be 14 and the Circumference 44; if you multiply half the Circumference 22 by 7 half the Diameter, the Product is 154; or if you multiply 11 the fourth part of the Circumference, by 14 the whole Diameter, the Product will ſtill be 154. And hence the Superficies of any Circle may be found though not exactly, yet near enough for any uſe.

2. But *Ludolphus Van Culen* finds the Circumference of a Circle whoſe Diameter is 1.00 to be 3.14159 the half whereof 1.57095 being multiplied by half the Diameter 50, *&c.* the Product is 7.85395 which is the *Area* of that Circle, and from theſe given Numbers, the *Area*, Circumference and Diameter of any other Circle may be found by the Proportions in the Propoſitions following.

Propoſition

Proposition I.

The Diameter of a Circle being given to find the Circumference.

As 1. to 3. 14159 : so is the Diameter to the Circumference. Example. In *Fig.* 13. Let the Diameter *IB* be 13. 25. I say as 1. to 3. 14159. so *IB*. 13.25 to 41.626 the Circumference of that Circle.

Proposition II.

The Diameter of a Circle being given to find the Superficial Content.

As 1. to 78539; so is the Square of the Diameter given, to the Superficial Content required. *Example*, Let the Diameter given be as before *IB* 13. 25 the Square thereof is 175. 5625 therefore.

As 1. to 78539: so 175. 5625 to 137. 88 the Superficial Content of that Circle.

Proposition III.

The Circumference of a Circle being given, to find the Diameter.

This is but the Converse of the first Proposition: Therefore as 3. 14159 is to 1 : so is the Circumference to the Diameter; and making the Circumference an Unite, it is. 3. 14159. 1 : : 1. 318308, and so an Unite may be brought into the first place. *Example*, Let the given Circumference

cumference be 41. 626. I ſay,

As 1. to 318308: ſo 41. 626 to 13. 25. the Diameter required.

Propoſition IV.

The Circumference of a Circle being given to find the Superficial Content.

As the Square of the Circumference of a Circle given is to the Superficial Content of that Circle: ſo is the Square of the Circumference of another Circle given to the Superficial Content required. *Example*, As the Square of 3. 14159 is to 7853938: ſo is 1. the Square of another Circle to 079578 the Superficial Content required, and ſo an Unite for the moſt eaſie working may be brought into the firſt place: Thus the given Circumference being 41. 626. I ſay,

As 1. to 0. 79578: ſo is the Square of 41. 626 to 137. 88 the Superficial Content required.

Propoſition V.

The Superficial Content of a Circle being given, to find the Diameter.

This is the Converſe of the ſecond Propoſition, therefore as 78539 is to 1. ſo is the Superficial Content given, to the Square of the Diameter required. And to bring an Unite in the firſt place: I ſay.

As 7853978. 1 : : 1. 1. 27324, and therefore if the Superficial Content given be 137, 88, to find the Diameter; I ſay,

As

As 1. to 1.27324: ſo 137.88 to 175.5625 whoſe Square Root is 13.25, the Diameter ſought.

Propoſition VI.

The Superficial Content of a Circle being given, to find the Circumference.

This is the Converſe of the Fourth Propoſition, and therefore as 079578 is to 1: ſo is the Superficial Content given, to the Square of the Circumference required, and to bring an Unite in the firſt place: I ſay,

As 079578. 1 :: .1. 12.5664, and therefore if the Superficial Content given be 137.88, to find that Circumference: I ſay,

As 1. to 12.5664: ſo is the 137.88 to 1732.7 whoſe Square Root is 626 the Circumference.

Propoſition VII.

The Diameter of a Circle being given to find the Side of the Square, which may be inſcribed within the ſame Circle.

The Chord or Subtenſe of the Fourth Part of a Circle, whoſe Diameter is an Unite, is 7071067, and therefore, as 1. to 7071067: ſo is the Diameter of another Circle, to the Side required. *Example*, let the Diameter given be 13.25 to find the ſide of a Square which may be inſcribed in that Circle: I ſay,

As 1. to 7071067: ſo is 13.25 to 9.3691 the ſide required.

Propoſition

Proposition VIII.

The Circumference of a Circle being given, to find the Side of the Square which may be inscribed in the same Circle.

As the Circumference of a Circle whose Diameter is an Unite, is to the side inscribed in that Circle; so is the Circumference of any other Circle, to the side of the Square that may be inscribed therein. Therefore an Unite being made the Circumference of a Circle.

As 3.14159 to 7071067: so 1. to 225078.

And therefore the Circumference of a Circle being as before 41.626, to find the side of the Square that may be inscribed: I say,

As 1. to 225078. so is 41.626 to 9.3691 the side inquired.

Proposition IX.

The Axis *of a Sphere or Globe being given, to find the Superficial Content.*

As the Square of the Diameter of a Circle, which is Unity, is to 3.14159 the Superficial Content, so is the Square of any other *Axis* given, to the Superficial Content required. *Example,* Let 13.25 be the Diameter given, to find the Content of such a Globe: I say,

As 1. to 3.14159: so is the Square of 13.25 to 551.54 the Superficial Content required.

Proposition X.

To find the Area *of an* Ellipsis.

As the Square of the Diameter of a Circle, is to the Superficial Content of that Circle; so is the Rectangle made of the Conjugate Diameters in an *Ellipsis*, to the *Area* of that *Ellipsis*; And the Diameter of a Circle being one, the *Area* is 7853975, therefore in *Fig*. 26. the Diameters *AC* 8 and *BD* 5 being given, the *Area* of the *Ellipsis* *ABCD* may thus be found.

As 1. to 7853975: so is the Rectangle *AC* in *BD* 40 to 3.1415900, the *Area* of the *Ellipsis* required.

CHAP. VIII.

Of the Measuring of Plain Triangles.

HAving shewed the measuring of a Circle, and *Ellipsis*, we come now to Right lined Figures, as the Triangle, Quadrangle, and Multangled Figures, and first of the measuring of the plain Triangles.

2. And the measuring of Plain Triangles is either in the measuring of the Sides and Angles, or of their *Area* and Superficial Content.

3. Plain Triangles in respect of their Sides and Angles are to be measured by two sorts of Lines, the one is a Line of equal Parts, and by that the Sides must be measured, the other is a Line of Chords, the Construction whereof hath been

been ſhewed in the ſixth Chapter, and by that the Angles muſt be meaſured, the Angles may indeed be meaſured by the Lines of Sines, Tangents or Secants, but the Line of Chords being not only ſufficient, but moſt ready, it ſhall ſuffice to ſhew how any Angle may be protracted by a Line of Chords, or the Quantity of any Angle found, which is protracted.

4. And firſt to protract or lay down an Angle to the Quantity or Number of Degrees propoſed, do thus, draw a Line at pleaſure as *AD* in *Figure* 5, then open your Compaſſes to the Number of 60 Degrees in the Line of Chords, and ſetting one Foot in *A*, with the other deſcribe the Arch *BG*, and from the Point *A* let it be required to make an Angle of 36 Degrees: open your Compaſſes to that extent in the Line of Chords, and ſetting one Foot in *B*, with the other make a mark at *G*, and draw the Line *AG*, ſo ſhall the Angle *BAG* contain 36 Degrees, as was required.

5. If the Quantity of an Angle were required, as ſuppoſe the Angle *BAG*, open your Compaſſes in the Line of Chords to the extent of 60 Degrees, and ſetting one Foot in *A*, with the other draw the Arch *BG*, then take in your Compaſſes the diſtance of *BG*, and apply that extent to the Line of Chords, and it will ſhew the Number of Degrees contained in that Angle, which in our Example is 36 Degrees.

6. In every Plain Triangle, the three Angles are equal to two right or 180 Degrees, therefore one Angle being given, the ſum of the other two is alſo given, and two Angles being given, the third is given alſo.

7. Plain

7. Plain Triangles are either Right Angled or Oblique.

8. In a Right Angled Plain Triangle, one of the Acute Angles is the Complement of the other to a Quadrant or 90 Degrees.

9. In Right Angled Plain Triangles, the Side ſubtending the Right Angle we call the *Hypotenuſe*, and the other two Sides the Legs, thus in *Fig.* 5. *AE* is the *Hypotenuſe*, and *AD* and *ED* are the Legs; theſe things premiſed, the ſeveral caſes in Right Angled and Oblique Angled Plain Triangles may be reſolved, by the Propoſitions following.

Propoſition I.

In a Right Angled Plain Triangle, the Angles of one Leg being given, to find the Hypotenuſe *and the other Leg.*

In the Right Angled Plain Triangle *ADE* in *Fig.* 5. Let the given Angles be *DAE* 36, and *DEA* 54, and let the given Leg be *AD* 476; to find the *Hypotenuſe AE*, and the other Leg *ED*.

Draw a Line at pleaſure, as *AD*, and by your Scale of equal Parts ſet from *A* to *D* 476 the Quantity of the Leg given, then erect a Perpendicular upon the Point *D*, and upon the Point *A* lay down your given Angle *DAE* 36 by the fourth hereof, and draw the Line *AE* till it cut the Perpendicular *DE*, then meaſure the Lines *AE* and *DE* upon your Scale of Equal Parts, ſo ſhall *AE* 588.3 be the *Hypotenuſe*, and *DE* 345.8 the other Leg.

Proposition II.

The Hypotenuse *and Oblique Angles given, to find the Legs.*

Let the given *Hypotenuse* be 588, and one of the Angles 36 degrees, the other will then be 54 degrees, Draw a Line at pleasure, as *AD*, and upon the Point *A* by the fourth hereof lay down one of the given Angles suppose the less, and draw the Line *AC*, and from your Scale of equal Parts, set off your *Hypotenuse* 588 from *A* to *E*, and from the Point *E* to the Line *AD* let fall the Perpendicular *E D*, then shall *AD* being measured upon the Scale be 476 for one Leg, and *E D* 345.8 the other.

Proposition III.

The Hypotenuse *and one Leg given to find the Angles and the other Leg.*

Let the given *Hypotenuse* be 588. and the given Leg 476. Draw a Line at pleasure as *AD*, upon which set the given Leg from *A* to *D*. 476, and upon the Point *D*, erect the Perpendicular *DE*, then open your Compasses in the Scale of Equal Parts to the Extent of your given *Hypotenuse* 588, and setting one Foot of that Extent in *A*, move the other till it touch the Perpendicular *DE*, then and there draw *AE*, so shall *ED* be 345.8 the Leg inquired, and the Angle *DAE*, will be found by the Line of Chords to be 36. whose Complement is the Angle *DEA*. 54.

Proposition

Proposition IV.

The Legs given to find the Hypotenuse, *and the Oblique Angles.*

Let one of the given Legs be 476, and the other 345.8, Draw the Line *AD* to the extent of 476, and upon the Point *D*, erect the Perpendicular *DE* to the extent of 345.8, and draw the Line *AE*, so shall *AE* be the *Hypotenuse* 588, and the Angle *DAE* will by the Line of Chords be found to be 36 Degrees, and the Angle *DEA* 54, as before.

Hitherto we have spoken of Right angled plain Triangles: the Propositions following concern such as are Oblique.

Proposition V.

Two Angles in an Oblique angled plain Triangle, being given, with any one of the three Sides, to find the other two Sides.

In any Oblique angled plain Triangle, let one of the given Angles be 26.50 and the other 38. and let the given Side be 632, the Sum of the two given Angles being deducted from a Semicircle, leaveth for the third Angle 115.50 Degrees, then draw the Line *BC* 632. and upon the Points *B* and *C* protract the given Angles, and draw the Lines *BD* and *CD*, which being measured upon your Scale of equal Parts *BD* will be found to be 312.43, and *BD* 431.09.

Proposition VI.

Two Sides in an Oblique Angled Triangle being given, with an Angle opposite to one of them, to find the other Angles and the third Side, if it be known whether the Angle Opposite to the other Side given be Acute or Obtuse.

In an Oblique Angled Plain Triangle, let the given Angle be 38 Degrees, and let the Side adjacent to that Angle be 632, and the Side opposite 431. 1. upon the Line *B C* in *Fig*. 25. protract the given Angle 38 Degrees upon the Point *C*, and draw the Line *D C*, then open your Compasses to the Extent of the other Side given 431. 1. and setting one Foot in *B*, turn the other about till it touch the Line *D C*, which will be in two places, in the Points *D* and *E*; if therefore the Angle at *B* be Acute the third Side of the Triangle will he *CE*, according therefore to the Species of that Angle you must draw the Line *B D* or *B E* to compleat the Triangle, and then you may measure the other Angles, and the third Side as hath been shewed.

Proposition VII.

Two Sides of an Oblique Angled Plain Triangle being given, with the Angle comprehended by them to find the other Angles and the third Side.

Let one of the given Sides be 632, and the other 431. 1, and let the Angle comprehended by them be Deg. 26. 50, draw a Line at pleasure, as

as *B C*, and by help of your Scale of Equal Parts, ſet off one of your given Sides from *B* to *C* 632. then upon the Point *B* protract the given Angle 26. 50. and draw the Line *B D*, and from *B* to *D*, ſet off your other given Side 431. 1. and draw the Line *D C*, ſo have you conſtituted the Triangle *B D C*, in which you may meaſure the Angles and the third Side, as hath been ſhewed.

Propoſition VIII.

The three Sides of an Oblique Angled Triangle being given, to find the Angles.

Let the length of one of the given Sides be 632, the length of another 431. 1, and the length of the third 312. 4, and Draw a Line at pleaſure, as *B C* in *Fig.* 25, and by help of your Scale of Equal Parts, ſet off the greateſt Side given 632 from *B* to *C*. then open your Compaſſes in the ſame Scale to the extent of either of the other Sides, and ſetting one Foot of your Compaſſes in *B*, with the other deſcribe an occult Arch, then extend your Compaſſes in the ſame Scale to the length of the third Side, and ſetting one Foot in *C* with the other deſcribe another Arch cutting the former, and from the Point of Interſection draw the Lines *B D* and *D C*. to conſtitute the Triangle *B D C*, whoſe Angles may be meaſured, as hath heen ſhewed.

And thus may all the Caſes of Plain Triangles be reſolved by Scale and Compaſs, he that deſires to reſolve them Arithmetically, by my *Trigometria Britannica*, or my little Geometrical Trigonometry; only one Caſe of Right Angled Plain

Triangles which I ſhall have occaſion to uſe, in the finding of the *Area* of the Segment of a Circle I will here ſhew how, to reſolve by Numbers.

Propoſition IX.

In a Right Angled Plain Angle the Hypotenuſe *and one Leg being given to find the other Leg.*

Take the Sums and difference of the *Hypotenuſe* and Leg given, then multiply the Sum by the Difference, and of the Product extract the Square Root, which Square Root ſhall be the Leg inquired.

Example. In *Fig.* 5. Let the given *Hypotenuſe* be *AE* 588.3, and the given Leg *AD* 476, and let *DE* be the Leg inquired. The Sum of *AE* and *AD* is 1064.3, and their Difference is 112.3, now then if you multiply 1064.3 by 112.3, the Product will be 119520.89, whoſe Square Root is the Leg *DE*. 345.8.

Propoſition X.

The Legs of a Right Angled Plain Triangle being gived, to find the Area *or Superficial Content thereof.*

Multiply one Leg by the other, half the Product ſhall be the Content. *Example,* In the Right angled plain Triangle *ADE*, let the given Legs be *AD* 476, and *DE* 345, and let the *Area* of that Triangle be required, if you multiply 476 by 345 the Product will be 164220, and the half thereof 82110 is the *Area* or Superficial Content required.

Propoſition

Proposition XI.

The Sides of an Oblique angled plain Triangle being given to find the Area *or Superficial Content thereof.*

Add the three Sides together, and from the half Sum subtract each Side, and note their Difference; then multiply the half Sum by the said Differences continually, the Square Root of the last Product, shall be the Content required.

Example. In *Fig.* 9. Let the Sides of the Triangle *ABC* be *AB* 20. *AC* 13, and *BC* 11 the Sum of these three Sides is 44, the half Sum is 22, from whence subtracting *AB* 20, the Difference is 2, from whence also if you subtract *AC* 13, the Difference is 9, and lastly, if you subtract *BC* 11 from the half Sum 22, the Difference will be 11. And the half Sum 22 being multiplied by the first Difference 2, the Product is 44, and 44 being multiplied by the Second Difference 9, the Product is 396, and 396 being multiplied by the third Difference 11, the Product is 4356, whose Square Root 66, is the Content required.

Or thus, from the Angle *C* let fall the Perpendicular *DC*, so is the Oblique angled Triangle *ABC*, turned into two right, now then if you measure *DC* upon your Scale of Equal Parts, the length thereof will be found to be 6. 6, by which if you multiply the Base *AB* 20, the Product will be 132. 0, whose half 66, is the *Area* of the Triangle, as before.

Proposition XII.

The Sides of any Oblique angled Quadrangle being given, to find the Area *or Superficial Content thereof.*

Let the Sides of the Oblique angled Quadrangle *ABED* in *Fig.* 11. be given, draw the Diagonal *AE*, and also the Perpendiculars *DC* and *BF*, then measuring *AE* upon the same Scale by which the Quadrangular Figure was protracted, suppose you find the length to be 632, the length of *DC* 112, and the length of *BF* 136, if you multiply *AE* 632 by the Half of *DC* 56, the Product will be 35392 the *Area* of *ACED*. In like manner if you multiply *AE* 632, by the half of *BF* 68, the Product will be 42976 the *Area* of *ACEB*, and the Sum of these two Products is the *Area* of *ABED* as was required.

Or thus, take the Sum of *DC* 112, and *BF* 136, the which is 248, and multiply *AE* 632 by half that Sum, that is by 124, the Product will be 78368 the *Area* of the Quadrangular Figure *ABED*, as before.

Proposition XIII.

The Sides of a plain irregular multangled Figure being given, to find the Content.

In *Fig.* 26. Let the Sides of the multangled Figure. *A.B.C.D.E.F.G.H.* be given, and let the *Area* thereof be required, by Diagonals drawn from the opposite Angles reduce the Figure given, into

into Oblique angled plain Triangles, and those Oblique angled Triangles, into right by letting fall of Perpendiculars, then measure the Diagonals and Perpendiculars by the same Scale, by which the Figure it self was protracted, the Content of those Triangles being computed, as hath been shewed, shall be *AF* the Content required: thus by the Diagonals *AG. BE* and *EC* the multangled Figure propounded is converted into three Oblique angled quadrangular Figures, *AFGH. AFEB* and *BEDC*, and each of these are divided into four Right angled Triangles, whose several Contents may be thus computed. Let *GA* 94 be multiplied by half *HL* 27 more Half of *KF* 29, that is by 23, the Product will be 21, be the *Area* of *AHGF*. Secondly, *OB* is 11, and *FN* 13, their half Sum 12, by which if you multiply *AE* 132, the Product will be 1584 the *Area* of *AFEB*. Thirdly, let *Bp* be 18 *mD* 32, the half Sum is 25, by which if you multiply *AEC* 125 the Product will be 3125 the *Area* of *BEDC*, and the Sum of these Products is 6871 the *Area* of the whole irregular Figure. *ABCDEFGH*, as was required.

Proposition XIV.

The Number of Degrees in the Sector *of a Circle being given, to find the* Area *thereof.*

In *Fig.* 27. *ADEG* is the *Sector* of a Circle, in which the Arch *DEG*, is Degrees. 23.50, and by 1. *Prop.* of *Archimed. de Dimensione Circuli*, the length of half the Arch is equal to the *Area* of the *Sector* of the double Arch, there the length

of

of *DE* or *EG* is equal to the *Area* of the *Sector* *ADEG:* and the length or circumference of the whole Circle whose Diameter is 1 according to *Van Culen*, is. 3. 14159265358979, therefore the length of one Centesme of a Degree, is. 0.01745329259. Now then to find the length of any Number of Degrees and Decimal Parts, you must multiply the aforesaid length of one Centesme by the Degrees and Parts given, and the Product shall be the length of those Degrees and Parts required, and the *Area* of a *Sector* containing twice those Degrees and Parts. *Example*, the half of *DEG* 23.50 is *DE* or *EG* 11.75, by which if you multiply 0.01745329259, the Product will be 2050761879325, the length of the Arch *DE*, and the *Area* of the *Sector* *ADEG*.

Proposition XV.

The Number of Degrees in the Segment of a Circle being given, to find the Area *of that Segment.*

In *Fig.* 27. Let the *Area* of the Segment *DEGK* be required, in which let the Arch *DEG* be Degrees 23.50, then is the *Area* of the *Sector* *ADEG* 2050761879325 by the last aforegoing, from which if you deduct the *Area* of the Triangle *ADG*, the remainer will be the *Area* of the Segment *DEGK*. And the *Area* of the Triangle *ADG* may thus be found. *DK* is the Sine of *DE* 11.75, which being sought in *Gellibrand*'s Decimal Canon is. 2036417511, and *AK* is the Sine of *DH* 78.25, or the Cosine of *DE*. 9790454724, which being multiplied by the Sine of *DE*, the Product will be 1993745344, or if you multiply *AG* the

Fig. 1.

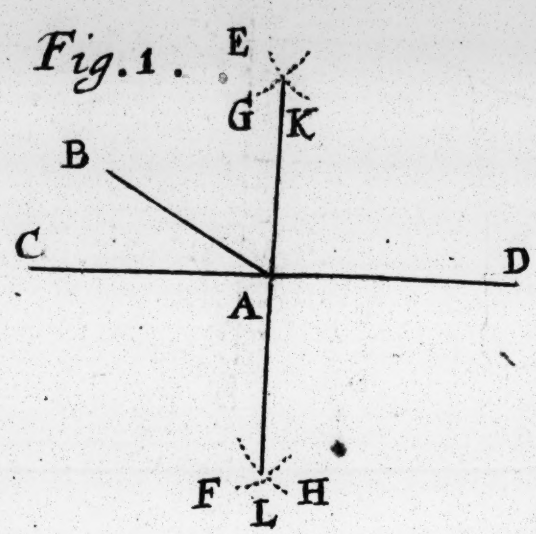


Fig. 2.

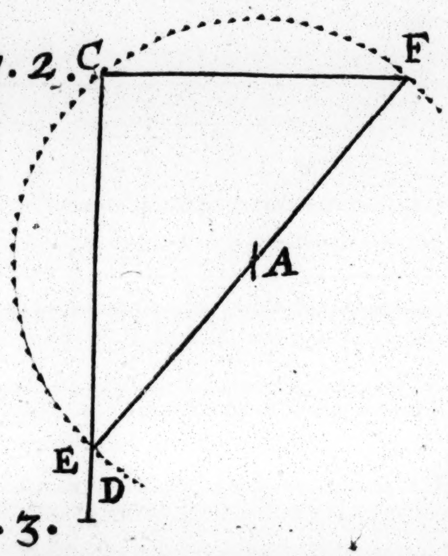


Fig. 3.

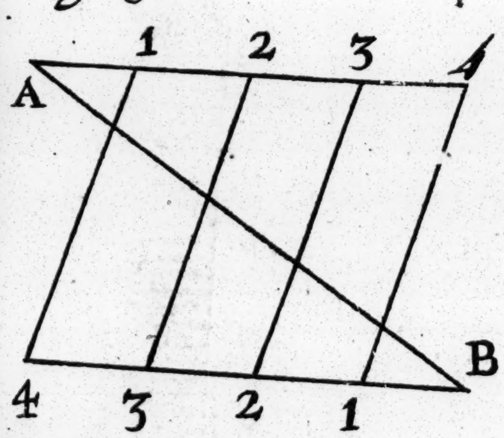


Fig. 4.

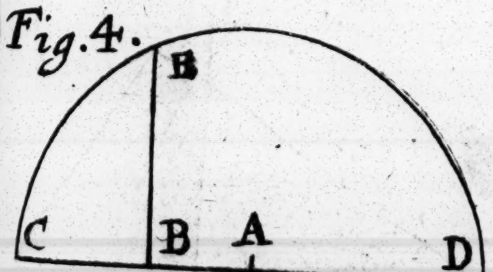


Fig. 5.

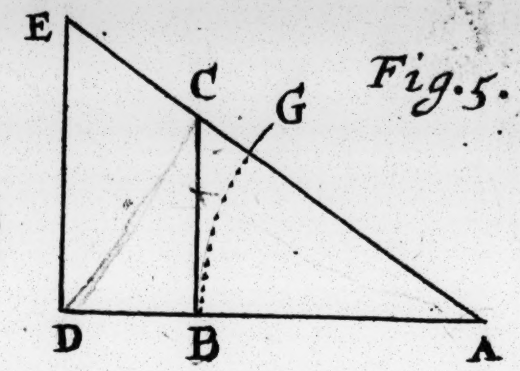


Fig. 6.

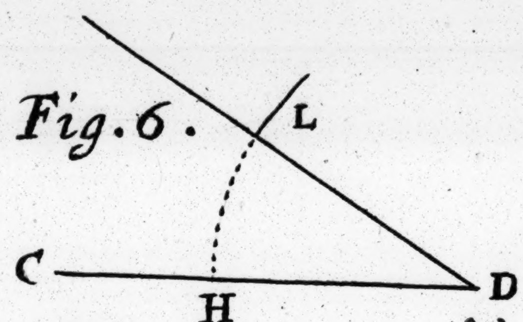


Fig. 7.

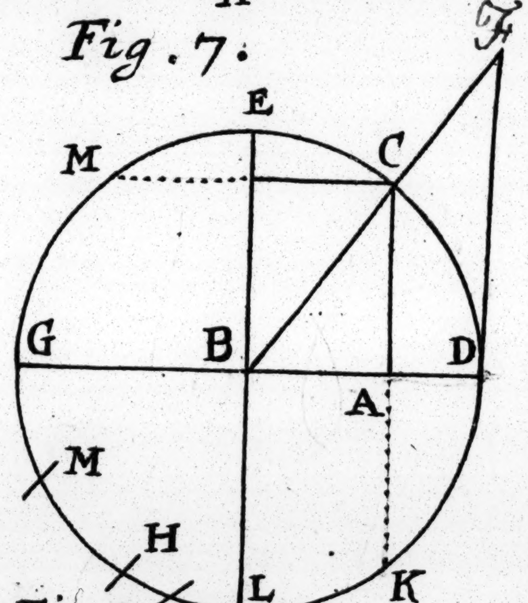


Fig. 8.

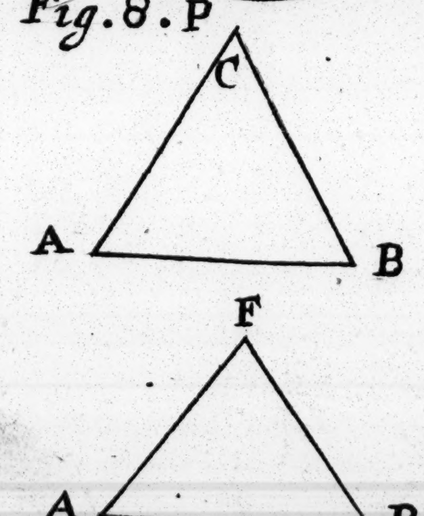


Fig. 9.

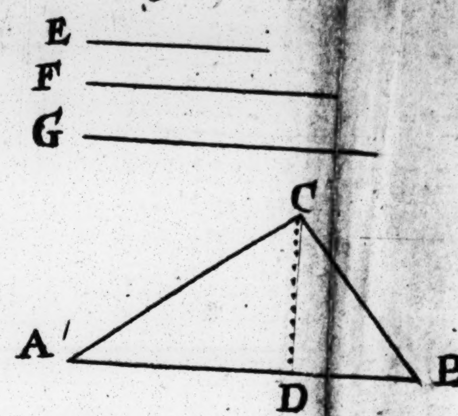


Fig. 10.

Fig. 11.

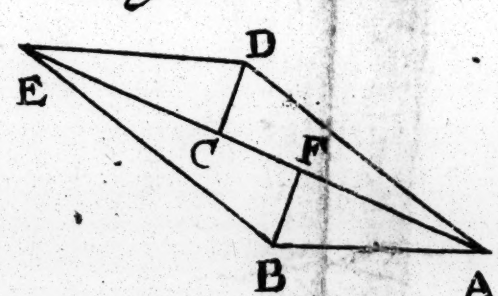


Fig. 12.

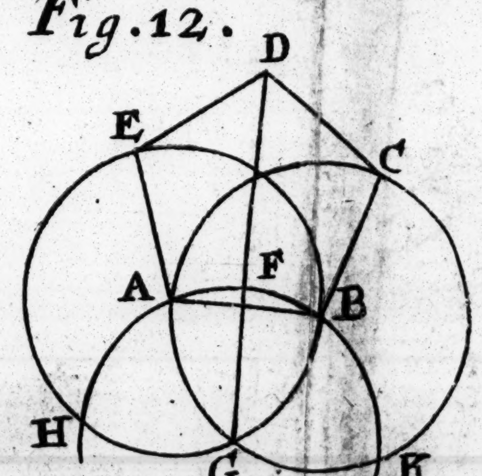


Fig. 13.

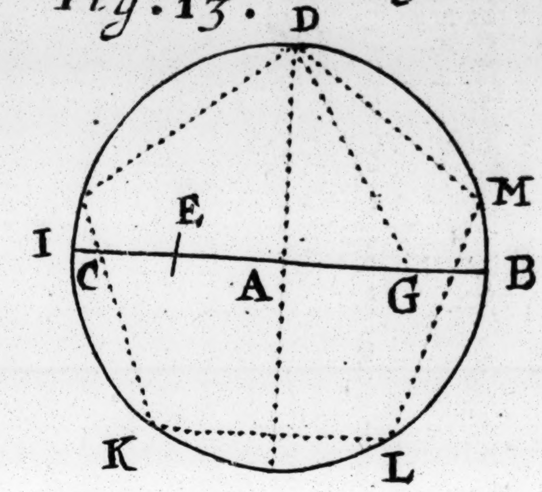


Fig. 14.

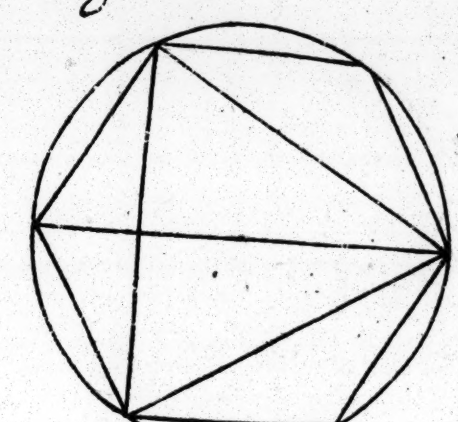
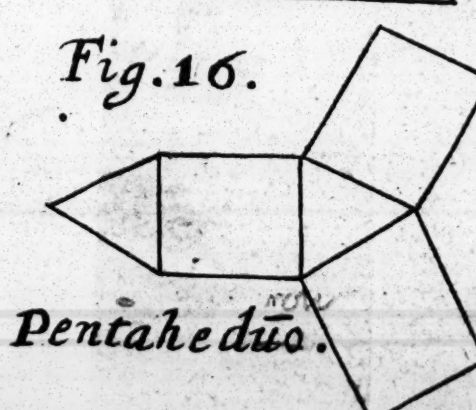


Fig. 15.

Tetrahedron

Fig. 16.



Pentahedron

18·2

170
300
800
200

16000 | 400

300

174532
1 82
349060
1396256
174532
31764824

1000
900
800

900
1000
1900.0

200
1900.0.0 | 464

46 | 300
276
524 | 2400
2096
5924 | 404
26

400
300

the

the *Radius* by half *D F* the Sine of the double Arch *D E G*, the Product will be 19937453445 as before, and this Product being deducted from the *Area* of the *Sector A D E G* 20507618793 25, the remainer will be 57016434875 the *Area* of the Segment *D E G L*, as was desired.

Proposition XVI.

The Diameter of a Circle being cut into any Number of Equal Parts, to find the Area *of any Segment made by the Chord Line drawn at Right Angles through any of those equal Parts of the Diameter.*

In *Fig.* 28. The *Radius A D* is cut into five Equal Parts, and the Segment *E D F L* is made by the Chord Line *E L F* at Right Angles to *A D* in the fourth Equal Part, or at eight tenths thereof: now then to find the *Area* of this Segment we have given *A E Radius*, and *A L* 8, and therefore by the ninth hereof *E L* will be found to be 600000, the Sine of *E D* 36. 87, by which if you multiply 0. 0174532, the Product is the *Area* of the *Sector A E D F* 64350286, and the *Area* of the Triangle *A E F* is 48, which being deducted from the *Area* of the *Sector*, the Remainer 16350286 is the *Area* of the ~~*Sector*~~ Segment *E D F L*, as was required. And in this manner was that Table of Segments made by the Chord Lines cutting the *Radius* into 100 Equal Parts.

Another way.

In *Fig.* 28. Let the *Radius A D* be cut into 10. 100 or 1000 Equal Parts, and let the *Area* of the

the Segments made by the Chord Lines drawn at Right Angles through all thoſe Parts be required: firſt find the Ordinates *G K* and *M. P N. E L*, the double of each Ordinate, will be the Chords of the ſeveral Arches, and the Sum of theſe Chords beginning with the leaſt Ordinate, will orderly give you the *Area* of the ſeveral Segments made by thoſe Chord Lines, but the Diameter muſt be be divided into 10000 Equal Parts, becauſe of the unequal differences at the beginning of the Diameter: but taking the *Area* of the Circle to be 3.1415926535, *&c.* as before, the *Area* of the Semicircle will be 1.57079632, from which if you deduct the Chord *G H* 1999999, the Chord anſwering to 999 Parts of the *Radius*, the remainer is. 1.56879632 the *Area* of the Segment *G D H*. And in this manner by a continual deduction of the Chord Lines from the *Area* of the Segment of the Circle given, was made that Table ſhewing the *Area* of the Segments of a Circle to the thouſandth part of the *Radius*.

And becauſe a Table ſhewing the *Area* of the Segments of a Circle to the thouſandth part of the *Radius*, whoſe whole *Area* is Unity, is yet more uſeful in Common Practice, therefore from this Table, was that Table alſo made by this Proportion.

As the *Area* of the Circle whoſe Diameter is Unity, to wit 3.14149 is to the *Area* of any part of that Diameter, ſo is Unity the ſuppoſed *Area* of another Circle, to the like part of that Diameter. *Example*, the *Area* anſwering to 665 parts of the *Radius* of a Circlewhoſe *Area* is 3.14159 is 0.91354794 therefore,

As 3.14159265 is to 0.91354794: So is 1. to

Fig. 17.

Cube.

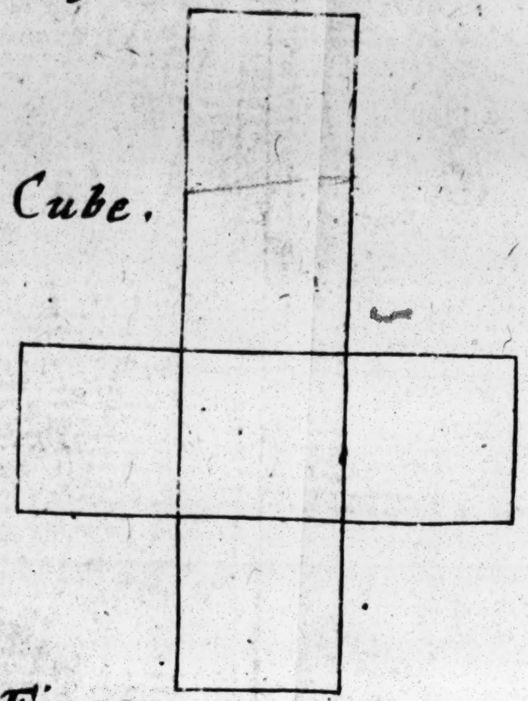
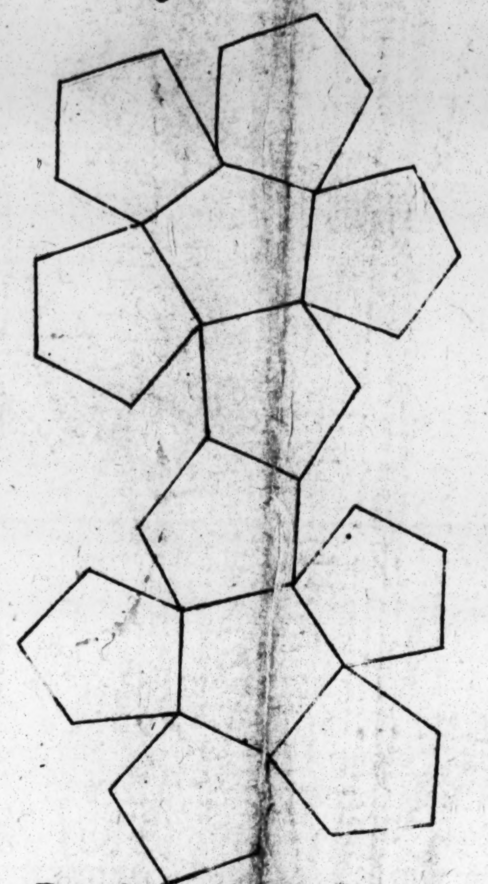


Fig. 20.



Dodecahedron.

Fig. 22.

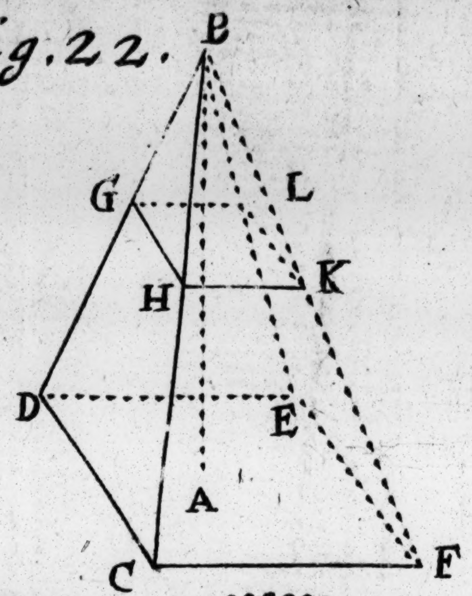


Fig. 25.

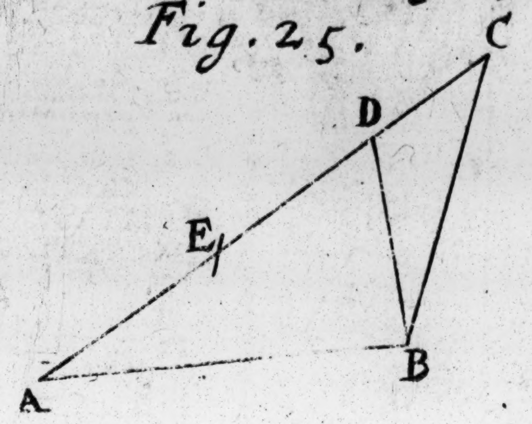


Fig. 18.

Octohedron.

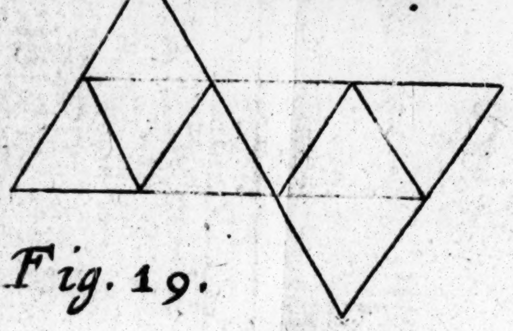


Fig. 23.

Fig. 26.

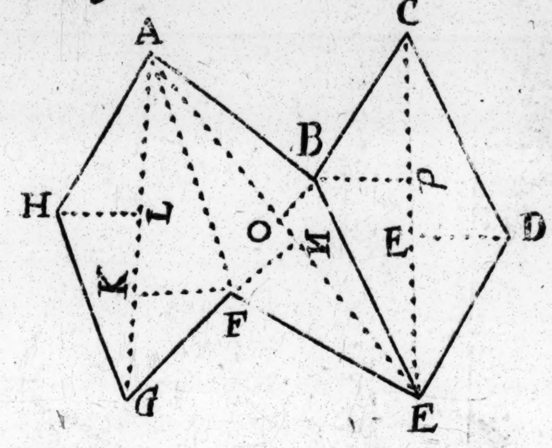
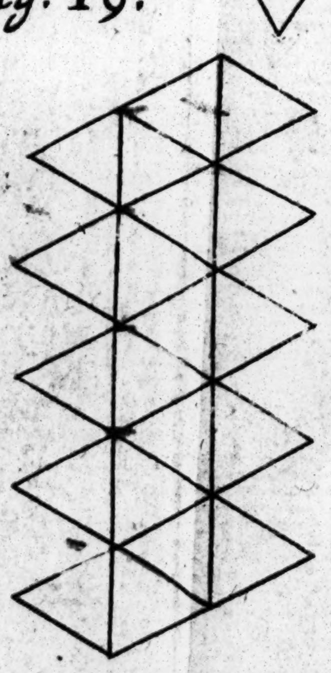


Fig. 19.



Icosahedron.

Fig. 21.

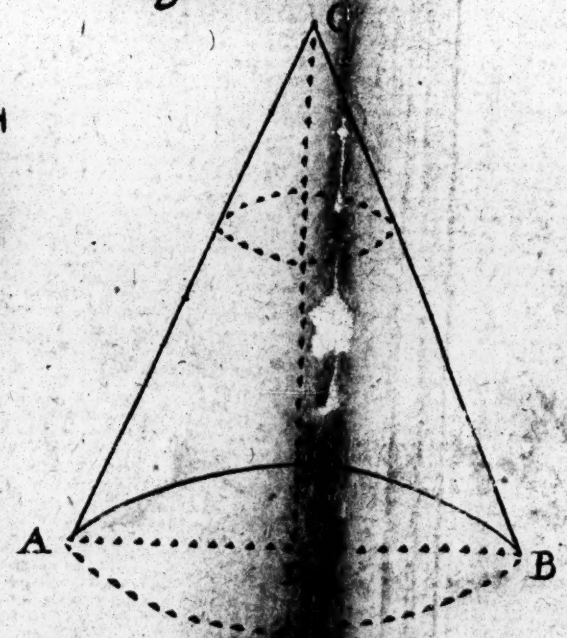


Fig. 24.

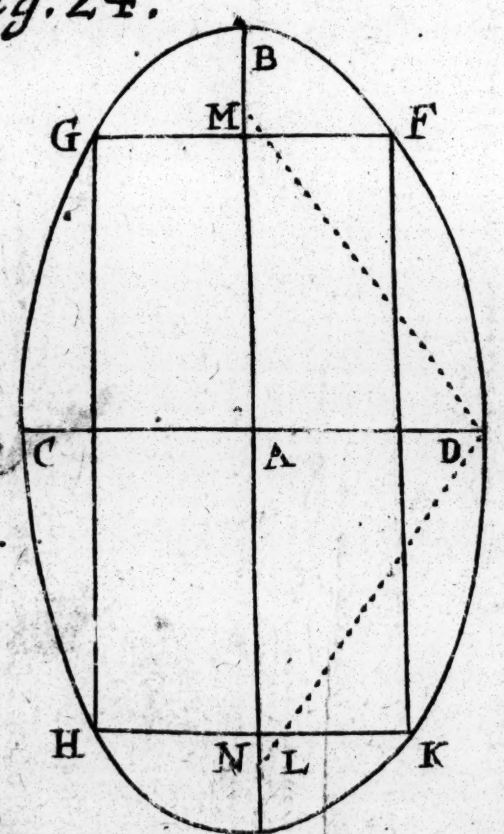


Fig. 27.

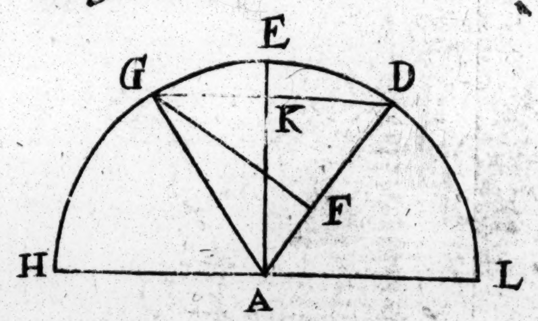
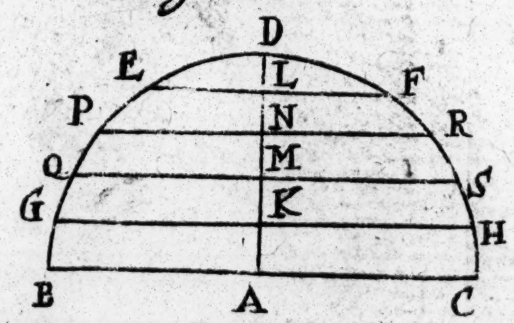


Fig. 28.



to 290791, the *Area* required; and the Table being thus computed to the 1000 parts of the *Radius*, we have enlarged it by the difference to the 5000 parts of the *Radius*, and consequently to the ten thousandth part of the Diameter: The use of which Table shall be shewed when we come to the measuring of Solid Bodies.

CHAP. IX.

Of the Measuring of Heights and Distances.

HAving shewed in the former Chapter, how all plain Triangles may be measured, not only in respect of their Sides and Angles, but in respect of their *Area*, and the finding of the *Area* of all other plain Figures also, that which is next to be considered, is the practical use of those Instructions, in the measuring of Board, Glass, Wainscot, Pavement, and such like, as also the measuring or surveying of Land; and first we will shew the measuring of Heights and Distances.

2. And in the measuring of Heights and Distances, besides a Chain of 50 or 100 Links, each Link being a Foot, it is necessary to have a Quadrant of four or five Inches *Radius*, and the larger the Quadrant is, the more exactly may the Angles be taken, though for ordinary Practice, four or five Inches *Radius* will be sufficient.

Let such a Quadrant therefore be divided in the Limb into 90 Equal Parts or Degrees, and numbred from the left hand to the right, at every tenth Degree, in this manner 10. 20. 30. 40 50. 60. 70. 80. 90. and within the Limb of the Quadrant

drant draw another Arch, which being divided by help of the Limb into two Equal Parts, in the Point of Interſection ſet the Figure 1. repreſenting the *Radius* or Tangent of 45 Degrees, and from thence both ways the Tangents of 63.44 Deg. 71.57 Deg. 75.97 Deg, 78.70 Deg. 80.54 Deg. that is, 2. 3. 4. 5 and 6 being ſet alſo, your Quadrant will be fitted for the taking of Heights ſeveral ways, as ſhall be explained in the Propoſitions following.

Propoſition I.

To find the Height of a Tower, Tree, or other Object at one Station.

At any convenient diſtance from the Foot of the Object to be meaſured, as ſuppoſe at *C* in *Fig.* 30. and there looking through the Sights of your Quadrant till you eſpie the top of the Object at *A*, obſerve what Degrees in the Limb are cut by the Thread, thoſe Degrees from the left Side or Edge of the Quadrant to the Right, is the Quantity of the Angle *ACB*, which ſuppoſe 35 Degrees; then is the Angle *BAC* 55 Degrees, being the Complement of the former to 90 Degrees. This done with your Chain or otherwiſe meaſure the diſtance from *B* the Foot of the Object, to your Station at *C*, which ſuppoſe to be 125 Foot. Then as hath been ſhewed in the 1. *Prop. Chap.* 8. draw a Line at pleaſure as *BC*, and by your Scale of Equal Parts, ſet off the diſtance meaſured from *B* to *C* 125 Foot, and upon the Point *C* lay down your Angle taken by obſervation 35 Degrees, then erect a Perpendicular upon the

the Point *B*, and let it be extended till it cut the Hypothenusal Line *AC*, so shall *AB* measured on your Scale of Equal Parts, be 87. 5 Foot for the Height of the Object above the Eye; to which the Height of the Eye from the Ground being added, their Sum is the Height required.

Another way.

Let *AB* represent a Tower whose Altitude you would take, go so far back from it, that looking through the Sights of your Quadrant, to the top of the Tower at *A* the Thread may cut just 45 Degrees in the Limb, then shall the distance from the Foot of the Tower, to your Station, be the Height of the Tower above the Eye.

Or if you remove your Station nearer and nearer to the Object, till your Thread hang over the Figures 2, 3. 4 or 5 in the Quadrant, the Height of the Tower at 2. will be twice as much as the distance from the Tower to the Station, at 3. it will be thrice as much, *&c.* As if removing my Station from *C* to *D*, the Thread should hang over 2 in the Quadrant, and the distance *B D* 62 Foot, then will 124 Foot be the Height of the Tower, above the Eye.

In like manner if you remove your Station backward till your Thread fall upon one of those Figures in the Quadrant, between 45 and 90 Degrees, the distance between the Foot of the Tower, and your Station will at 2. be twice as much as the Height, at 3. thrice as much, at 4. four times so much, and so of the rest.

A

A Third way by a Station at Random.

Take any Station at pleaſure ſuppoſe at *C*, and looking through the Sights of your Quadrant, obſerve what Parts of the Quadrant the Thread falls upon, and then meaſure the diſtance between the Station, and the Foot of the Object, that diſtance being multiplied by the parts cut in the Quadrant, cutting off two Figures from the Product ſhall be the Height of the Object above the Eye.

Example, Suppoſe I ſtanding at *C*, that the Thread hangs upon 36 Degrees, as alſo upon 72 in the Quadrant which is the Tangent of the ſaid Arch, and let the meaſured diſtance be *CB* 125 Foot, which being multiplied by 72, the Product is 9000, from which cutting off his Figures becauſe the *Radius* is ſuppoſed to be 100, the Height inquired will be 90 Foot, he that deſires to perform this work with more exactneſs, muſt make uſe of the Table of Sines and Tangents Natural or Artificial, this we think ſufficient for our preſent purpoſe.

Propoſition II.

To find an inacceſſible Height at two Stations.

Take any Station at pleaſure as at *D*, and there looking through the Sights of your Quadrant to the top of the Object, obſerve what Degrees are cut by the Thread in the Limb, which admit to be 68 Degrees, then remove backward, till the Angle taken by the Quadrant, be but half ſo much

as

as the former, that is 34 Degrees, then is the distance between your two Stations equal to the Hypothenusal Line at your first Station, *viz.* *AD*. if the distance between your two Stations were 326 foot, then draw a Line at pleasure as *B D*, upon the Point *D* protract, the Angle *ADB* 68 Degrees, according to your first Observation, and from your Line of equal parts set off the Hypothenusal 326 Foot from *D* to *A*, and from the Point *A* let fall the Perpendicular *AB* which being measured in your Scale of Equal Parts, shall be the Altitude of the Object inquired.

Or working by the Table of Sines and Tangents, the Proportion is.

As the *Radius*, is to the measured distance or Hypothenusal Line *AD*; so is the Sine of the Angle *ADE*, to the height *AB* inquired.

Another more General way, by any two Stations taken at pleasure.

Admit the first Station to be as before at *D*, and the Angle by observation to be 68 Degrees, and from thence at pleasure I remove to *C*, where observing aim I find the Angle at *C* to be 32 Degrees, and the distance between the Stations 150 Foot. Draw a Line at pleasure as *B C*, and upon *C* lay down your last observed Angle 32 Degrees, and by help of your Scale of Equal Parrs, set off your measured distance from *C* to *D* 150 Foot, then upon *D* lay down your Angle of 68 Degrees, according to your first Observation, and where the Lines *AD* and *AC* meet, let fall the Perpendicular *AB*, which being measured in your Scale of Equal Parts, shall be the height of the Object as before.

Or working by the Tables of Sines and Tangents, the Proportions.

1. As the Sine of *D AC* to the Distance *DC*. So the Sine of *ACD*, to the Side *AD*.

2. As the *Radius*, to the Side *A D*; so the Sine *ADB*, to the Perpendicular height *AB* inquired.

The taking of Distances is much after the same manner, but because there is required either some alteration in the sights of your Quadrant or some other kind of Instrument for the taking of Angles, we will particularly shew, how that may be also done several ways, in the next Chapter.

CHAP. X.

Of the taking of Distances.

FOr the taking of Distances some make use of a Semicircle, others of a whole Circle, with Ruler and Sights rather than a Quadrant, and although the matter is not much by which of these Instruments the Angles be taken, yet in all Cases the whole Circle is somewhat more ready, than either a Semicircle or Quadrant, the which with its Furniture is called the Theodolite.

2. A piece of Board or Brass then about twelve or fourteen Inches Diameter, being made Circular like a round Trencher, must be divided into four Quadrants, and each Quadrant divided into 90 Degrees, or the whole Circle into 360, and each Degree into as many other Equal Parts, as the largeness of the Degrees will well permit: let your Circle be numbred both ways to 360, that is from the right hand to the left, and from the left to the right.

3. Upon

3. Upon the backside of the Circle there must be a Socket made fast, that it may be set upon a three legged Staff, to bear it up in the Field.

4. You must also have a Ruler with Sights fixed at each end, for making of Observation, either fixed upon the Center of your Circle, or loose, as you shall think best; your Instrument being thus made, any distance whether accessible or inaccessible may thus be taken.

5. When you are in the Field, and see any Church, Tower, or other Object, whose Distance from you, you desire to know, choose out some other Station in the same Field, from whence you may also see the Object, and measure the distance between your Stations; then setting your Ruler upon the Diameter of your Circle, set your Instrument so, as that by the Sights on your Ruler, you may look to the other Station, this done turn your Ruler to that Object whose distance you desire to know, and observe how many Degrees of the Circle are cut by the Ruler, as suppose 36 Degrees, as the Angle *ACD* in *Fig.* 30. Then removing your Instrument to *D*, lay the Ruler on the Diameter thereof, and then turn the whole Instrument about till through your Sights you can espy the mark set up at your first Station at *C*, and there fix your Instrument, and then upon the Centre of your Circle turn your Ruler till through the Sights you can espy the Object whose distance is inquired, suppose at *A*; and observe the Degrees in the Circle cut by the Ruler, which let be 112, which is the Angle *ADC*, and let the distance between your two Stations be *DC* 326 Foot; so have you two Angles and the side between them, in a plain Triangle given, by which

to find the other sides, the which by protraction may be done as hath been shewed, in the fifth Proposition of Chapter 8. but by the Table of Sines and Tangents, the Proportion is.

As the Sine of *DAC*, is to *DC*; so is the Sine of *ACD* to the Side *AD*.

Or, as the Sine of *DAC*, is to the given Side *DC*.

So is the Sine of *ADC* to the Side *AC*.

6. There is another Instrument called the plain Table, which is nothing else, but a piece of Board, in the fashion and bigness of an ordinary sheet of paper, with a little frame, to fasten a sheet of paper upon it, which being also set upon a Staff, you may by help of your Ruler, take a distance therewith in this manner.

Having measured the distance between your two Stations at *D* and *C*, draw upon your paper a Line, on which having set off your distance place your Instrument at your first Station *C*, and laying your Ruler upon the Line so drawn thereon, turn your Instrument till through the Sights you can espy the Station at *D*, then laying your Ruler upon the Point *C*, turn the same about till through the Sights you can espy the Object at *A*, and there draw a Line by the side of your Ruler, and remove your Instrument to *D*, and laying your Ruler upon the Line *DC*, turn the Instrument about, till through the Sight you can espy the Mark at *C*, and then laying your Ruler upon the Point *D*, turn the same, till through the Sights you can espy the Object at *A*, and by the side of your Ruler draw a Line, which must be extended till it meet with the Line *AC*, so shall the Line *AD* being measured upon your Scale of Equal Parts,

Parts, be the distance of the Object from *D*, and the Line *A C* shall be the distance thereof from *C*.

7. And in this manner may the distance of two, three or more Objects be taken, from any two Stations from whence the several Objects may be seen, and that either by the plain Table, or Theodolite.

CHAP. XI.

How to take the Plot of a Field at one Station, from whence the several Angles may be seen.

ALthough there are several Instruments by which the Plat of a Field may be taken, yet do I think it sufficient to shew the use of these two, the plain Table and Theodolite.

2. In the use of either of which the same chain which is used in taking of heights and distances, is not so proper. I rather commend that which is known by the Name of *Gunter*'s Chain, which is four Pole divided into 100 Links; being as I conceive much better for the casting up the Content of a Piece of Ground, than any other Chain that I have yet heard of, whose easie use shall be explained in its proper place.

3. When you are therefore entered the Field with your Instrument, whether plain Table, or Theodolite, having chosen out your Station, let visible Marks be set up in all the Corners thereof, and then if you use the plain Table, make a mark upon your paper, representing your Station, and laying your Ruler to this Point, direct

your Sights to the ſeveral Corners of the Field, where you have cauſed Marks to be ſet up, and draw Lines by the ſide of the Ruler upon the paper to the point repreſenting your ſtation, then meaſure the diſtance of every of theſe Marks from your Inſtrument, and by your Scale ſet thoſe diſtances upon the Lines drawn upon the paper, making ſmall marks at the end of every ſuch diſtance, Lines drawn from Point to Point, ſhall give you upon your paper, the Plot of the Field, by which Plot ſo taken the content of the Field may eaſily be computed.

Example. Let *Fig.* 31. repreſent a Field whoſe Plot is required; your Table being placed with a ſheet of paper thereupon, make a Mark about the middle of your Table, as at *A*. apply your Ruler from this Mark to *B* and draw the Line *A B*, then with your Chain meaſure the diſtance thereof which ſuppoſe to be 11 Chains 36 Links, then take 11 Chains 36 Links from your Scale, and ſet that diſtance from *A* to *B*, and at *B* make a mark.

Then directing the Sights to *C*, draw a Line by the ſide of your Ruler as before, and meaſure the diſtance *A C*, which ſuppoſe to be 7 Chains and 44 Links, this diſtance muſt be taken from your Scale, and ſet from *A* to *C* upon your paper.

And in this manner you muſt direct your Sights from Mark to Mark, until you have drawn the Lines and ſet down the diſtances, between all the Angles in the Field and your ſtation, which being done, you muſt draw the Lines from one Point to another, till you conclude where you firſt began, ſo will thoſe Lines *BC. CD. DE. FG.* and *G B*, give you the exact Figure of the Field.

4. To do this by the Theodolite, in ſtead of drawing

drawing Lines upon your paper in the Field, you muſt have a little Book, in which the Pages muſt be divided into five Columns, in the firſt Column whereof you muſt ſet ſeveral Letters to ſignifie the ſeveral Angles in the Field, from which Lines are to be drawn to your place of ſtanding, in the ſecond and third Columns the degrees and parts taken by your Inſtrument, and the fourth and fifth, to ſet down your diſtances Chains and Links, this being in readineſs, and have placed your Inſtrument direct your Sights to the firſt mark at *B*, and obſerve how many Degrees are comprehended between the Diameter of your Inſtrument, and the Ruler, and ſet them in the ſecond and third Columns of your Book againſt the Letter *B*, which ſtands for your firſt Mark, then meaſure the diſtance *AB* as before, and ſet that down, in the fourth and fifth Columns, and ſo proceed from Mark to Mark, until you have taken all the Angles and Diſtances in the Field, which ſuppoſe to be, as they are expreſſed in the following Table.

	Degr.	*Part*	*Chains*	*Links*
B	39	75	11	56
C	40	75	7	44
D	96	00	7	48
E	43	25	8	92
F	80	00	6	08
G	59	25	9	73

5. Having thus taken the Angles and Diſtances in the Field, to protract the ſame on Paper or

 Parchment,

Parchment, cannot be difficult; for if you draw a Line at pleaſure as *E B* repreſenting the Diameter of your Inſtrument about the middle thereof, as at *A*, mark a Mark, and opening your Compaſſes to 60 Degrees in your Line of Chords, upon *A* as a Center deſcribe a Circle, then lay your Field book before you ſeeing that your firſt Obſervattion cut no Degrees, there are no Degrees to be marked out in the Circle, but the Degrees at *C* are 40. 75 which being taken from your Line of Chords, you muſt ſet them from *H* to *I*, and draw the Line *A I*. the Degrees at *D* are 96 which muſt in like manner be ſet from *I* to *K*, and ſo the reſt in order.

This done obſerve by your Field-book the length of every Line, as the Line *AB* at your firſt Obſervation was 11 Chains and 36 Links, which being by your Scale ſet from *A* will give the Point *B* in the Paper, the ſecond diſtance being ſet upon *AI* will give the Point *C*, and ſo proceediug with the reſt, you will have the Points *B C D E F* and *G*, by which draw the Lines *B C*. *C D*. *D E*; *E F*. *F G* and *G B*, and ſo at laſt you have the Figure of the Field upon your Paper, as was required.

And what is here done at one ſtation, may be done at two or more, by meaſuring one or two diſtances from your firſt ſtation, taking at every ſtation, the Degrees and diſtances to as many Angles, as are viſible at each ſtation.

And as for taking the the Plot of a-Field by Interſection of Lines, he that doth but conſider how the diſtances of ſeveral Objects may be taken at two ſtations, will be able to do the other alſo, and therefore I think it needleſs, to make any illuſtration by example.

CHAP.

CHAP. XII.

How to take the Plot of a Wood, Park or other Champion Plain, by going round the same, and making Observation at every Angle.

BY these Directions which have been already given, may the Plot of any Field or Fields be taken, when the Angles may be seen alone or more stations within the Field, which though it is the case of some Grounds, it is not the case of all; now where observation of the Angles cannot be observed within, they must be observed without, and although this may be done by the plain Table, yet as I judge it may be more conveniently done by the Theodolite, in these cases thereof I chiefly commend that Instrument, I know some use a MarinersCompass, but the working with a Needle is not only troublesom, but many times uncertain, yet if a Needle be joyned with the Theodolite the joynt Observations of the Angles may serve to confirm one another.

2. Suppose the *Fig.* 32. to be a large Wood whose Plot you desire to take; Having placed your Instrument at the Angle *A*, lay your Ruler on the Diameter thereof, turning the whole Instrument till through the Sights you espy the Angle at *K*, then fasten it there, and turn your Ruler upon the Center, till through the Sights you espy your second Mark at *B*, the Degrees cut by the Ruler do give the quantity of that Angle *BAK*, suppose 125 Degrees, and the Line *AB* 6 Chains, 45 Links, which you must note in your Field-book, as was shewed before.

3. Then

3. Then remove your Instrument to *B*, and laying your Ruler upon the Diameter thereof, turn it about, till through the Sights you can espy your third mark at *C*, and there fasten your Instrument, then turn the Ruler backward till through the Sights you see the Angle at *A*, the Degrees cut by the Ruler being 106. 25 the quantity of the Angle *ABC*, and the Line *BC* containing 8 Chains and 30 Links, which note in your Field-book, as before.

4. Remove your Instrument unto *C*, and laying the Ruler on the Diameter thereof, turn the Instrument about till through the Sights you see the Angle at *D*, and fixing of it there, turn the Ruler upon the Center till you see your last station at *B*, and observe the Degrees cut thereby, which suppose to be 134 Degrees, and the Line *CD* 6 Chains 65 Links, which must be entered into your Field-book also, and because the Angle *BCD* is an inward Angle, note it with the Mark > for your better remembrance.

5. Remove your Instrument unto *D*, and laying the Ruler on the Diameter, turn the Instrument about, till through the Sights, you see the Angle at *E*, and there fixing your Instrument, turn your Ruler backward till you espy the Mark at *C*, where the Degrees cut are, suppose 68.0 and the Line *DE* 8 Chains and 23 Links.

6. Remove your Instrument unto *E*, and laying the Ruler on the Diameter, turn the Instrument about, till through the Sights you see the Angle at *F*, and there fix it, then turn the Ruler backward till you see the Angle at *D*, where the Degrees cut by the Ruler suppose to be 125 and the Line *EF* 7 Chains and 45 Links.

7. Re-

7. Remove your Instrument unto *F*, and laying your Ruler upon the Diameter, turn the Instrument about, till through the Sights, you see the Angle at *G*, where fix the same, and turn the Ruler backward till you see the Angle at *E*, where the Degrees cut by the Ruler are 70, and the Line *F G* 4 Chains 15 Links, which must be set down with this > or the like Mark at the Angle.

8. Remove your Instrument unto *G*, and laying your Ruler upon the Diameter, turn the Instrument about, till through the Sights you see the Angle at *H*, where fix the same, and turn the Ruler backward till you see the Angle at *F*, where the Degrees cut by the Ruler are 65. 25, and the Line *G H* 5 Chains 50 Links.

9. Remove your Instrument in like manner to *H* and *K*, and take thereby the Angles and Distances as before, and having thus made observation at every Angle in the Field, set them down in your Field-book, as was before directed, the which in our present Example will be as followeth.

A	151.00 ——	6.45
B	106.25 ——	8.30
C >	134.00 ——	6.65
D	68.00 ——	8.23
E	125.00 ——	7.45
F >	70.25 ——	4.15
G	65.25 ——	5.50
H	130.00 ——	6.50
K	140.00 ——	11.00

The taking of the inward Angles *B C D* and *E F G* was more for Conformity sake than any necessity,

necessity, you might have removed your Instrument from *B* to *D*, from *E* to *G*, the Length of the Lines *B C. C D. E F* and *G*, would have given by protraction the Plot of the Field without taking these Angles by observation; many other compendious ways of working there are, which I shall leave to the discretiou of the Ingenious Practitioner.

10. The Angles and Sides of the Field being thus taken, to lay down the same upon Paper, Parchment, another Instrument called a Protractor is convenient, the which is so well known to Instrument-makers, that I shall not need here to describe it, the chief use is to lay down Angles, and is much more ready for that purpose than a Line of Chords, though in effect it be the same.

11. Having then this Instrument in a readiness draw upon your Paper or Parchment upon which you mean to lay down the Plot of that Field, a Line at pleasure as *AB*. Then place the Center of your Protractor upon the Point *A*, and because the Angle of your first observation at *A* was 115 Degrees 00 Parts, turn your Protractor about till the Line *AK* lie directly under the 115 Degree; and then at the beginning of your Protractor make a Mark, ând draw the Line *A B*, setting off 6 Chains 45 Links from *A* to *B*.

12. Then lay the Center of your Protractor upon the Point *B*, and here turn your Protractor about, till the Line *A B* lie under 106 Degrees 25 Parts, and draw the Line *B C*, setting off the Distance 8 Chains, 30 Links from *B* to *C*.

13. Then lay the Center of your Protractor upon the Point *C*, and turn the same about till the Line *B C* lie under 134 Degrees, but remember to

to make it an inward Angle, as it is marked in your Field-Book, and there make a Mark, and draw the Line *CD*, ſetting off 6 Chains, 65 Links from *C* to *D*.

And thus muſt you do with the reſt of the Sides and Angles, till you come to protract your laſt Angle at *H*, which being laid down according to the former Directions the Line *HK* will cut the Line *AK* making *AK* 11 Chains and *HK* 6 Chains, 50 Links. This work may be alſo performed by protracting your laſt obſervation firſt; for having drawn the Line *AK*, you may lay the Center of your Protractor upon the Point *K*, and the Diameter upon the Line *AK*; and becauſe your Angle at *K* by obſervation was 140 Degrees, you muſt make a Mark by the Side of your Protractor at 140 Degrees; and draw the Line *KH*, ſetting off 6 Chains, 50 Links from *K* to *H*. And thus proceeding with the reſt of the Lines and Angles, you ſhall find the Plot of your Field at laſt to cloſe at *A*, as before it did at *K*.

CHAP. XIII.

The Plot of the Field being taken by any Inſtrument, how to compute the Content thereof in Acres, Roods, and Perches.

THe meaſuring of many ſided plain Figures hath been already ſhewed in the 13 *Propoſition* of the 8 *Chapter*, which being but well conſidered, to compute the Content of a Field cannot be difficult; It muſt be remembred indeed that 40 ſquare Pearches do make an Acre.

2. Now

2. Now then if the Plot be taken by a four Pole Chain divided into 100 Links, as 16 ſquare Poles are the tenth part of an Acre; ſo 10.000 ſquare Links of ſuch a Chain are equal to 16 ſquare Pole, or Perches; and by conſequence 100.000 ſquare Links are equal to an Acre, or the ſquare Pearches.

3. Having then converted your Plot into Triangles, you muſt caſt up the Content of each Triangle as hath been ſhewed, and then add the ſeveral Contents into one Sum, and from the aggregate cut off five Figures towards the right hand; the remainer of the Figures towards the left hand are Acres, and the five Figures ſo cut off towards the right hand are parts of an Acre, which being multiplied by four, if you cut off five Figures from the Product, the Figures remaining towards the left hand are Roods, and the five Figures cut off are the parts of a Rood, which being multiplied by forty, if you cut off five Figures from the Product, the Figures remaining towards the left hand are Perches, and the Figures cut off are the Parts of a Pearch.

Example. Let 258.94726 be the Sum of ſeveral Triangles, or the Content of a Field ready caſt up, the three Figures towards the left hand 258 are the Acres, and the other Figures towards the right hand 94726 are the Decimal Parts of an Acre, which being multiplied by 4, the Product is 3.78904, that is three Roods and 78904 Decimal Parts of a Rood, which being multiplied by 40, the Product is 31.56160, that is 31 Perches and 56160 Decimal Parts of a Perch; and therefore in ſuch a Field there are Acres 258, Roods 3, Pearches 31, and 56160 Decimal Parts of a Perch.

CHAP.

CHAP. XIV.

How to take the Plot of Mountainous and uneven Grounds, and how to find the Content.

WHen you are to take the Plot of any Mountainous or uneven piece of Ground, such as is that in *Figure* 33, you must first place your Instrument at *A*, and direct your Sights to *B*, measuring the Line *AB*, observing the Angle *GAB*, as was shewed before, and so proceed from *B* to *C*, and because there is an ascent from *C* to *D*, you must measure the true length thereof with your Chain, and set that down in your Book, but your Plot must he drawn according to the length of the Horizontal Line, which must be taken by computing the Base of a right angled Plain Triangle, as hath been shewed before, and so proceed from Angle to Angle until you have gone round the Field, and having drawn the Figure thereof upon your Paper, reduce into Triangles and *Trapezias*, as *ABC. CDE. ACEF* and *AFG.* then from the Angles *B. C. D. F* and *G*; let fall the Perpendiculars, *BK. CN. DL. FM.* and *GH.* This done you must measure the Field again from Angle to Angle, setting down the Distance taken in a straight Line over Hill and Dale, and so likewise the several Perpendiculars, which will be much longer than the streight Lines measured on your Scale, and by these Lines thus measured with your Chain cast up the Content; which will be much more than the Horizontal Content of that Field according to the Plot, but if it should be otherwise plotted than by the Horizontal

rizontal Lines, the Figure thereof could not be contained within its proper limits, but being laid down among other Grounds, would force ſome of them out of their places, and therefore ſuch Fields as theſe muſt be ſhadowed off with Hills, if it be but to ſhew that the Content thereof is computed according to the true length of the Lines from Corner to Corner, and not according to their Diſtance meaſured by Scale in the Plot.

CHAP. XV.

How to reduce Statute Meaſure into Cuſtomary, and the contrary.

WHereas an Acre of Ground by Statute Meaſure is to contain 160 ſquare Perches, meaſured by the Pole or Perch of ſixteen foot and a half: In many places of this Nation, the Pole or Perch doth by cuſtom contain 18 foot, in ſome 20. 24. 28 Foot; it will be therefore required to give the Content of a Field according to ſuch ſeveral quantities of the Pole or Perch.

2. To do this you muſt conſider how many ſquare Feet there is in a Pole according to theſe ſeveral Quantities.

In 16. 5 to the Pole, there are 272. 25 ſq. feet.
In 18 to the Pole there are 324 ſquare feet.
In 20 to the Pole there are 400 ſquare feet.
In 24 to the Pole there are 576 ſquare feet.
In 28 to the Pole there are 784 ſquare feet.

Now then if it were deſired to reduce 7 Acres, 3 Roods, 27 Perches, according to Statute Meaſure, into Perches of 18 Foot to the Perch; firſt reduce

duce your given quantity, 7 Acres. 3 Rods, 27 Poles into Perches, and they make 1267 Perches.

Then say, as 324. to 272. 25. so is 1267 to 1065.6. that is 1065 Perches, and 6 tenths of a Perch. But to reduce customary Measure into statute measure, say as 272.25. is to 324 so is 1267 Perches in customary measure, to 1507. 8 that is 1507 Perches and 8 tenths of a Perch in statute measure, the like may be done, with the customary measures of 20. 24 and 28 or any other measure that shall be propounded.

CHAP. XVI.

Of the Measuring of solid Bodies.

HAving shewed how the content of all plains may be computed, we are now come to the measuring of solid Bodies, as Prisms, Pyramids and Spheres, the which shall be explained in the Propositions following.

Proposition. I.

The base of a Prism or Cylinder being given, to find the solid content.

The base of *a Prism* is either Triangular, as the *Pentahedron*; Quadrangular, as the *Hexahedron*, or Multangular, or the *Polyhedron* Prism, all which must be computed as hath been shewed, which done if you multiply the base given by the altitude, the product shall be the solid content required.

Example. In an *Hexahedron* Prism, whose base

is quadrangular, one side of the Base being 65 foot and the other 43, the Superficies or Base will be 27.95. Which being multiplyed by the Altitude, suppose 12.5. the product. 359.375. is the solid content required.

In like manner the Base of a Cylinder being 45.6. and the altitude 15.4. the content will be 702.24.

And in this manner may Timber be measured whether round or squared, be the sides of the squared Timber equal or unequal.

Example. Let the Diameter of a round piece of Timber be 2.75 foot. Then, As 1 it to 785397. so is the square of the Diameter 2.75. to 5.9395 the Superficial content of that Circle.

Or if the circumference had been given 8.64. then, As 1 is to 079578, so is the square of 8.64. to 5.9404 the superficial content.

Now then if you multiply this Base 5.94. by the length, suppose 21 foot, the content will be 124.74.

If the side of a piece of Timber perfectly square be 1.15 this side being multiplyed by it self, the product will be 1.3225 the superficial content, or content of the Base, which being multiplyed by 21 the length, the content will be 27.7745.

Or if a piece of Timber were in breadth 1.15. in depth 1.5 the content of the Base would be 1.725 which being multiplied by 21 the length, the content will be 36.225.

Proposition. II.

The Base and Altitude of a Pyramid or Cone being given, to find the solid content.

Multiply

Multiply the Altitude by a third part of the Base, or the whole Base by a third part of the Altitude, the Product shall be the solid content required.

Example. In a Pyramid having a Quadrangular Base as in *Fig.*22. The side *CF* 17. *CD* 9. 5. the Product is the Base *CDEF.* 161. 5, which being multiplyed by 10.5 the third of the Altitude *AB* 31. 5 the Product is 1695. 75 the content. Or the third of the Base. *viz.* 53. & 3 being multiplied by the whole Altitude *AB* 31.5 the Product will be the content as before.

2. Example. In *Fig.* 21. Let there be given the Diameter of the Cone *AB* 3.5. The Base will be 96.25. whose Altitude let be *CD* 16.92 the third part thereof is 5.64 & 96.25 being multiplied by 5.64, the Product 542.85 is the solid content required.

Proposition. III.

The Axis of a Sphere being given, to find the solid content.

If you multiply the Cube of the Axis given by 523598 the solid content of a Sphere whose Axis is an unite, the Product shall be the solid content required.

Example. Let the Axis given be 3, the Cube thereof is 27, by which if you multiply. 523598, the Product 14.137166 is the solid content required.

Proposition. IV.

The Basis and Altitude of the Frustum *of a Pyramid or Cone being given, to find the content.*

If the aggregate of both the Bases of the *Frustan* and the mean proportional between them, shall be multiplied by the third part of the Altitude, the Product shall be the solid content of the *Frustum*.

Example. In *Fig.* 22. Let *CDEF* represent the greater Base of a Pyramid, whose superficial content let be 1.92, and let the lesser Base be *HGLKO*. 85 the mean proportional between them is. 1.2775 and the aggregate of these three numbers is. 4.0475. Let the given Altitude be 15. the third part thereof is. 5 by which if you multiply 4.0475 the Product 20.2375 is the content of the *Frustum* Pyramid.

And to find the content of the *Frustum* Cone. I say.

As. 1. 1078539. so 20.23 to 15. 884397, the content of the Cone required.

But if the Bases of the *Frustum* Pyramid shall be square, you may find the content in this manner.

Multiply each Diameter by it self and by one another, and the aggregate of these Products, by the third part of the altitude, the last Product shall be the content of the *Frustum* Pyramid.

Example. Let the Diameter of the greater Base be 144, the Diameter of the lesser Base 108, and the altitude 60.

The

The Square of 144 is	20736
The Square of 108 is	11664
The Product of 144+108 is	15552
The Sum of these 3 Products is	47952

Which being multiplyed by 20 the third part of the Altitude, the Product 959040 is the content of the *Frustum* Pyramid.

And this content being multiplied by .785 39 the content of the *Frustum* Cone will be. 753.228.

Another way.

Find the content of the whole Pyramid of the greater and lesser Diameter, the lesser content deducted from the greater, the remain shall be the content of the *Frustum*. To find the content of the whole Pyramid, you must first find their several Altitudes in this manner.

As the difference between the Diameters,
Is to the lesser Diameter.
So is the Altitude given, to the Altitude cut off.

Example. The difference between the former Diameter. 144. and 108 is 36, the Altitude 60. now then As 36. 108 :: 60. 108. the altitude cut off.

Now then if you multiply the lesser Base 11664 by 60 the third part of 180 the Product 699840 is the content of that Pyramid.

And adding 60 to 180 the Altitude of the greater Pyramid is 240, the third part whereof is 80, by which if you multiply the greater Base before found, 70736, the Product is the content of the

greater Pyramid. 1658880, from which if you deduct the lesser 699840 the remainer 959040 is the content of the *Frustum* Pyramid as before.

And upon these grounds may the content of Taper Timber, whether round or square, and of Brewers Tuns, whether Circular or Elliptical, be computed, as by the following Propositions shall be explained.

Proposition. V.

The breadth and depth of a Taper piece of Squared Timber, both ends being given together with the length, to find the content.

Let the given Dimensions.
At the Bottom be *A*. 5.75 and *B* 2.34
At the Top. *C*. 2.16 and *D*. 1.83
And let the given length be 24 Foot.

According to the last Proposition, find the Area or Superficial content of the Tree at both ends thus.

Multiply the breadth	3.75	0.574031
By the depth	2.34	0.369215
The Product	8.7750	0.943246

2. Multiply the breadth	2.16	0.334453
By the depth	1.82	0.262451
The Product is	3.9528	0.596904

3. Multi-

3. Multiply the 1. Content.	8.7750	0.943246
by the second content.	3.9528	0.596904
And find the square root	5.8986	1.540150
		0.770075

The Sum of these 18.6264 being multiplyed by 8 one third of the length, the content will be found to be 149.0112. Thus by the Table of Logarithms the mean proportional between the two Bases is easily found, and without extracting the square Root, may by natural Arithmetick be found thus.

A + ½ *C* x A half *C* multiplyed by *B*: And *C* more half *A* multiplyed by *D* being added together and multiplyed by 30, the length shall give the content. Example.

A.	3.75		*C* 2.16
½ *C.*	1.08		½ *A* 1.875
Sum	4.83	Sum.	4.035
B-	2.34	*D.*	1.83
	1932		12105
	1449		32280
	966		4035
	11.3022		7.38405
			11.30220

The sum of the Products 18.68625

Being multiplyed by 8 the third of the length, the content will be. 149.49000. The like may be done for any other.

 6. Pro-

Propoſition. VI.

The Diameters of a piece of Timber being given at the Top and and Bottom, together with the length, to find the content.

The Propoſition may be reſolved either by the Squares of the Diameters, or by the Areas of the Circles anſwering to the Diameters given, for which purpoſe I have here annexed not only a Table of the Squares of all numbers under a thouſand, but a Table ſharing the third part of the Areas of Circles in full meaſure, to any Diameter given under 3 foot.

And therefore puttiug $S =$ The Sum of the Tabular numbers anſwering to the Diameters at each end.

$X =$ The difference between theſe Diameters.

$L =$ the length of the Timber, $C =$ The content.

Then $1\frac{1}{2} S = \frac{1}{3}\text{-}XX. + L. = C.$

If you work by the Table of the ſquares of Numbers. you muſt multiply the leſs ſide of the Equation, by 0.26179 the third part of 0.78539 the Product being multiplyed by the length, will give the content.

But if you work by the Table of the third parts of the Areas of Circles in full meaſure, the tabular Numbers being multiplyed by the length will give the content. Only inſtead of the ſquare of the difference of the Diameter, you muſt take half the Tabular number anſwering to that Difference, and you ſhall have the content as before. Example.

Let

Let the greatest Diameter by 2.75, and the less 1.93.

Their difference is 0.83

The square of 2.75 is	7.5625
The square of 1.93 is	3.7249.
The Sum of the Squares	11.2874
The half Sum	5.6437
The Sum of them is	16.9311
Half the square of 0.82 deduct.	0.3362
The Difference is	16.5949
Which being multiplyed by	26179
	1493541
	1161643
	165949
	995694
	331898
The Product will be.	4.344378871

Or

Or by the Table of Areas.

The Area of 2.75 is	1.979857
The Area of 1.93 is	0.975176
The Sum	2.955033
The half Sum	1.477516
The Sum of them	4.432549
Half the Area of 0.82 deduct	0.088016
The former Product	4.344533
Which being multiplyed by	24
	17378132
	8689066
The content is	104268792

But becauſe that in meaſuring of round Timber the circumference is uſually given and not the Diameter, I have added another Table by which the circumference being given, the Diameter may be found.

Example. Let the circumference of a piece of Timber be 8325220 looking this Number in the ſecond column of that Table, I find the next leſs to be 8.168140 and thence proceeding in a ſtreight Line, I find that in the ſeventh Column the Number given, and the Diameter anſwering thereunto to be 2.65. and thus may any other Diameter be found not exceeding the three foot. The Proportion by which the Table was made, is thus. As 1. to 3.14159 ſo is the Diameter given, to the circumference required. Or

2
301

60) 344 (5
300
182
30

44 5460
1278

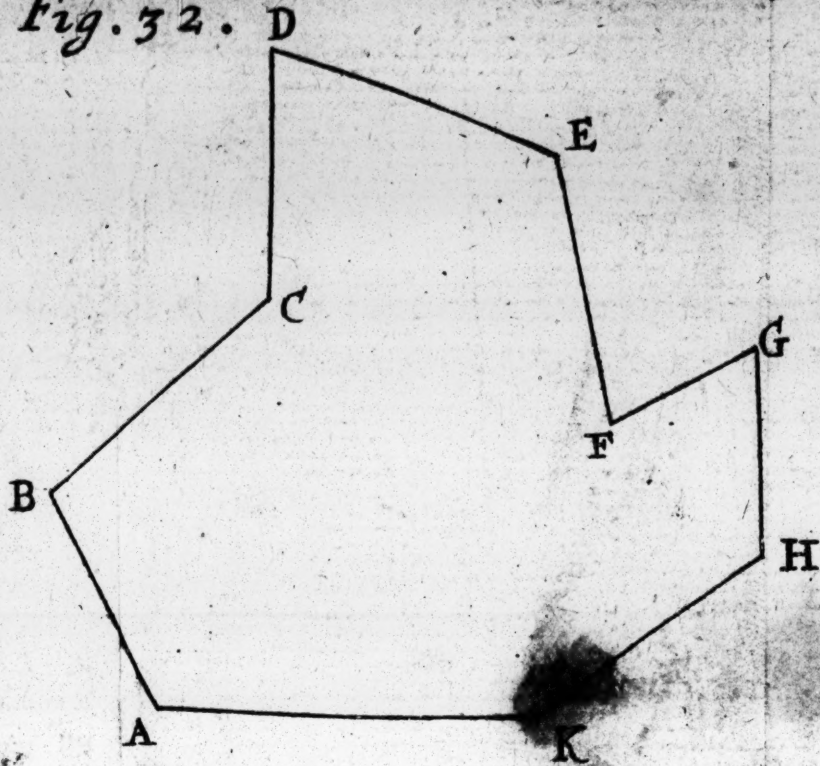
6 35
600

12 1085
3550

30
3
90
6
540
12

2
12
540
120

Fig. 32.



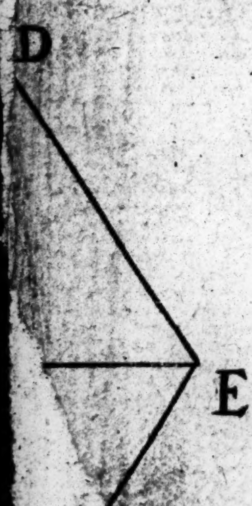
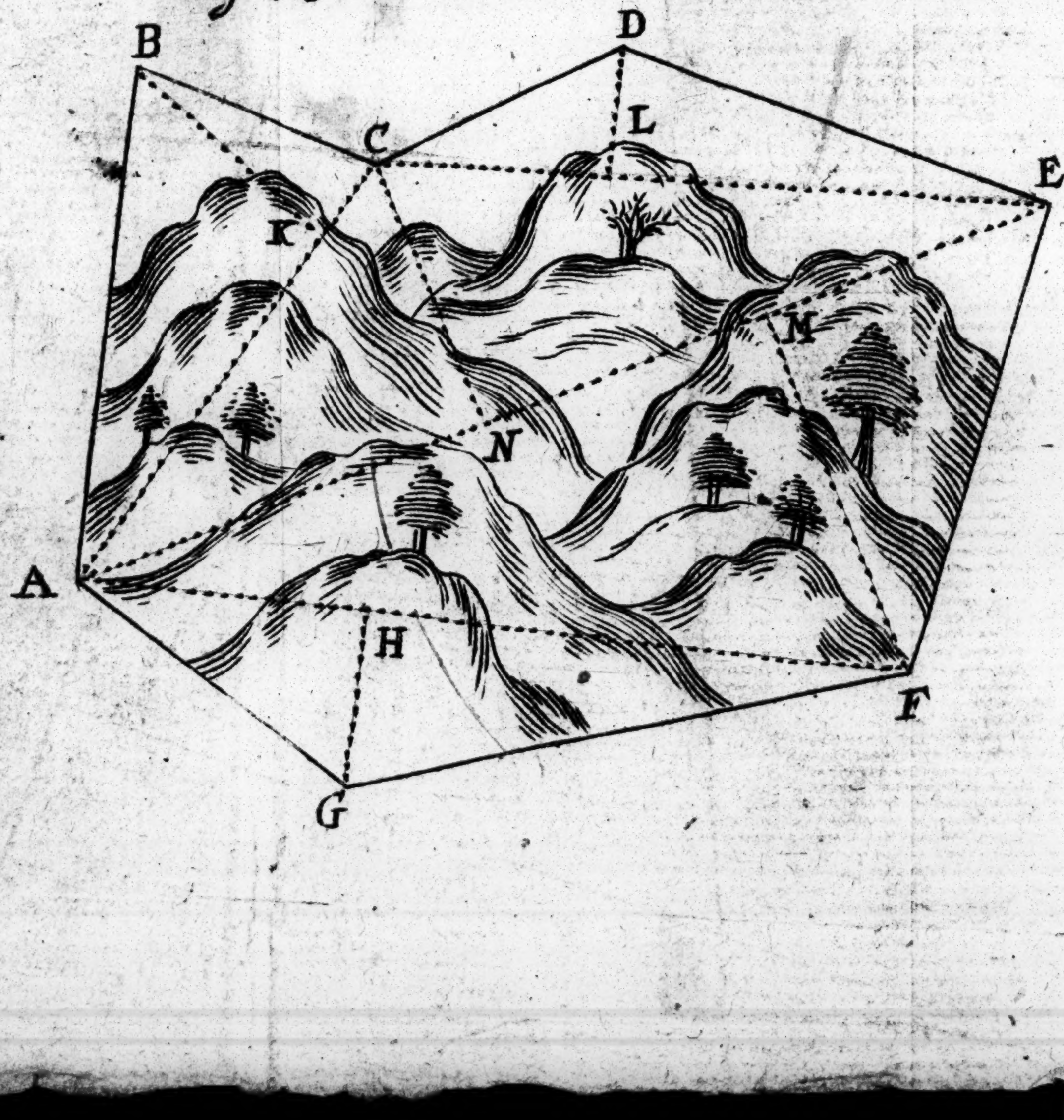


Fig. 33.



Or the Circumference being given, to find the Diameter, say: As. 1.to.0.3183, so is the Circumference given to the Diameter required.

And although by these two Tables all round Timber may be easily measured, yet it being more usual to take the Circumference of a Tree, then the Diameter, I have here added a third Table, shewing the third part of the Areas of Circles answering to any circumference under 10 foot, and that in Natural and Artificial numbers, the use of which Table shall be explained in the Proposition following.

Proposition. VII.

The Circumference of a piece of round Timber at both ends, with the length being given, to find the content.

The Circumference of a Circle being given, the Area thereof may be found as hath been shewed, in the 7 Chapter, Proposition 4. and by the first Proposition of this; and to find the third part of the Area, which is more convenient for our purpose I took a third part of the number given by which to find the whole, that is a third part of 07957747 that is 0.02652582 and having by the multiplying this number by the square of the Circumference computed three or four of the first numbers, the rest were found by the first and second differences.

The Artificial numbers were computed by adding the Logarithms of the Squares of the circumference, to 8.42966891 the Logarithm of 0.02652582.

And by these Natural and Artificial numbers the

553

the content of round Timber may be found two ways

By the Natural numbers in the ſame manner as the content was computed, the Diameters being given, and by the Natural and Artificial numbers both, by finding a mean proportional between the two Areas at the top and bottom of the Tree, as by Example ſhall be explained.

Let the given Dimenſions, or Circumferences be
At the Bottom 9.95
At the Top 3.75
Their difference is 6.20

The tabular Numbers.

		Natural	Artificial.
Anſwering to	9.95	2.626162	0.418931
And to	3.75	0.373019	9.571731
The Sum of the Logarith.			9.990662
The half Sum or Logarith.		989300	9.995331

The Sum of the Number is 3.988481

The Sum of the Natural Numbers is	2.999181
The half Sum	1.499190
The Sum of them	4.498771
Half the number anſwer. to 6.20 is	0.509826
The remainer is	3.988945

Which being multiplyed by the length 24, the content will be 95.73468.

Mr. *Darling* in his Carpenters Rule made eaſie, doth propound a ſhorter way, but not ſo exact, which is by the Circumference given in the middle of the piece to find the ſide of the Square, namely

ly by multiplying the Circumference given by 28209, or 2821. which side of the Square being computed in Inches, and lookt in his Table of Timber measure, doth give the content of the Tree not exceeding 31 foot in length, the which way of measuring may be as easily performed by this Table. *Example.*

The circumference at the top and bottom of the Tree being given 9.95 and 3.75 the Sum is 13.70

The half thereof is the mean circumfer. 6.85

Which sought in the Table, the Numbers are.

The Natural number is 1.244657, which being multiplyed by 3 the Product is 3.733971, which multiplyed by the length 24, the content is 89.615304.

The Artificial number is	0.095049
The Logarithm of 24 is	1.380211
The Absolute Number 29.871	1.475260
Which multiplyed by 3, the Product is	89613

Proposition. VIII.

The Diameters of a Brewers Tun at top and bottom being given with the height thereof, to find the content.

In *Fig.* 29. Let the given Diameter.

At the top be *AC* 136 *B D* 128
At the bottom. *KG* 152 *HF* 144 Altit. 51 Inches.

The which by the 5 Proposition of this Chap. may thus be computed. *AC* 139 + ½ *KG* 76 = 212 x *B D* 128 the Product is 27136.

And

And KG 152 + $\frac{1}{2}$ AC 68 = 220 x HF 144 the Product is 31680. the Sum of these 2 Products is 58816 which being multiplyed by one third of 51, that is by 17, and that Product multiplyed by 26179 the third of 78539 will give the content.

The Logarithm of 58816. is	54.76949
The Logarithm of 17 is	1.230449
The Product	1.999944
The Logarithm of. 26179	9.417968
The content is. 261765	5.417912

Thus the content of a Tun may be found in Inches, which being divided 282 the number of Inches in an Ale Gallon, the quotient will be the content in Gallons.

Or thus; divide the former. 26179 by 282 the quotient will be,00092836. by which the content may be found in Ale Gallons in this manner.

The former Product	5.999944
The Logarithm of 0.00092836	6.967719
The content in Gallons 928.24	2.967663

Proposition. IX.

The Diameters of a close Cask, at head and bung with the length given, to find the content.

In the resolving of this Proposition, we are to consider the several forms of Casks, as will as the kind of the Liquor, with which it is filled, for one and the same Rule will not find the content in all Cask. And

And a Coopers Cask is commonly taken, either for the middle *Frustum* of a Spheroid, the middle *Frustum* of a Parabolical Spindle, the middle *Frustum* of two Parabolick Conoids, or for the middle *Frustum* of two Cones abutting upon one common Base.

And the content of these several Casks may be found either by equating the Diameters, or by equating the Circles. for the one, a Table of Squares is necessary, and a Table shewing the third part of the Areas of a Circle to all Diameters. The making of the Table of Squares, every one knows, to be nothing else but the Product of a Number multiplyed, by it self, thus the Square of 3 is 9. the Square of 8 is 64 and so of the rest.

And the Area of a Circle to any given Diameter may be found, as hath been shewed, in Chap. 7 Proposition 2. But here the Area of a Circle in Inches, will not suffice, it will be more fit for use, if the third part of the Area be found in Ale and Wine Gallons both, the which may indeed be done by dividing the whole Area in Inches by 3 and the quotient by 282 to make the Table for Ale-measure, and by 231 to make the Table for Wine-measure; but yet these Tables (*as I think*) may be more readily made in this manner.

The Square of any Diameter in Inches, being divided by 3.81972 will give the Area of the Circle in Inches: And this Division being multiplyed by 282 will give you 1077.161 for a common Division, by which to find the Area in Ale-Gallons, or being multiplyed by 231 the Product, 882.355 will be a commou Division by which to find the Area in Wine-Gallons.

But because it is easier to multiply then divide:

If

If you multiply the ſeveral Squares by 26178 the third part of 78539 the Product will give the Area in Inches, or if you divide. 26179 by 282 the quotient will be.00092886 for a common Multiplicator, by which to find the Area in Ale-Gallons, or being divided by 231 the quotient will be 0011333 a common Multiplicator, by which to find the content in Wine-Gallons. An Example or two will be ſufficient for illuſtration. Let the Diameter given be 32 Inches, the Square thereof 1024 being divided by 3.81970 the quotient is 268.083, and the ſame Square 1024 being multiplyed by 261799, the Product will be 268.082.

Again if you divide 1024 by 1077.161 the quotient will be 9508, or being multiplied by 00092836, the Product will be 9508.

Laſtly if you divide 1024 by 882.755, the quotient will be 1.1605, or being multiplied by 00113333 the Product is 1.1605,

And in this manner may the Tables be made for Wine and Beer-meaſure, but the ſecond differences in theſe Numbers being equal, three or four Numbers in each Table being thus computed, the reſt may be found by Addition only.

Thus the Squares of 1. 2. 3. and 4 Inches are. 1.4.9 and 16 by which if you multiply 00113333, the ſeveral Products will be third part of the Area, of the Circles anſwering to thoſe Diameters in Wine-Gallons. Or 00092836 being multiplied by thoſe Squares, the ſeveral Products, will be the third part of the Areas of the Circles anſwering to thoſe Diameters in Ale-Gallons; the which with their firſt and ſecond differences are as followeth.

The

7000

The Products or Areas in Wine-Gallons.

1.	00113333		
2.	00453332	339999	226666
3.	01019997	566665	226666
4.	01813328	796331	

The Products in Ale-Gallons.

1.	00092836		
2.	00371344	278508	185672
3.	00835524	464180	185672
4.	01485376	649852	

And by the continual addition of the second differences to the first, and the first differences to the products before found, the Table may be continued as far as you please.

The construction of the Tables being thus shewed: We will now shew their use in finding the content of any Cask.

Let $S =$ the Sum of the Tabular Numbers answering to the Diameters at the Head and Bung. $D =$ their difference $X =$ the difference of the Diameters themselves. $L =$ the length of the Vessel, and $C =$ the content thereof.

1. If a Cask be taken for the middle *Frustum* of a Spheroid, intercepted between two Planes parallel, cutting the Axis at right Angles: Then $1\frac{1}{5} S + \frac{1}{5} D \times L = C$.

2. If a Cask be taken for the middle *Frustum* of a parabolical Spindle, intercepted between two planes parallel cutting the Axis at right Angles. Then $1\frac{1}{5} S + \frac{1}{5} D \times L = C$.

3. If a Cask be taken for the middle *Frustum* of two Parabolick Conoids, abutting upon one common Base, intercepted between two Planes parallel, cutting the Axis at right Angle: Then $1\frac{1}{3}S : \times L = C.$

4. If a Cask be taken for the middle *Frustum* of two Cones, abutting upon one common base, intercepted between two Planes parallel cutting the Axis at Right Angles. Then $1\frac{1}{3}S - \frac{1}{3}XX. \times L = C.$

In all these four Equations, if you work by the Table of Squares of numbers, you must multiply the less side of the Equation by 262, if you would have the content in Cubical Inches; by 001133 if you would have the content in Wine-Gallons; and by 000928, if you would have the content in Ale-Gallons.

But if you work by the Tables of the third parts of the Areas Circle, the Tabular Numbers being multiplyed by the length only will give the content required, only in the fourth Equation instead of half the Square of the Difference of the Diameters, take half the Tabular Number answering to that difference, and you shall have the content required; as by the following Examples will better appear, then by many words.

Examples in Wine-measure by the Table of the Squares of Numbers.

The Diameter of a Vessel
At the Bung being 32 Inches.
At the Head 22 Inches.
The difference of the Diameters 10 Inches.
And the length of the Vessel 44 Inches.

Spheroid

Spheroid.	Parabolick Spindle.
1024	1024
484	484
1508	1508
754	754
270	540
2532	23160
2532	23160
7596	69480
7596	69480
7596	69480
28695156	262472280
44	44
114780624	104988912
114780624	104988912
126.2586864	115.4878032

Parabolick Conoid	Cone.
1024	1024
484	484
1508	1508
754	754
	50
2262	2212
2262	2212
6786	6636
6786	6636
6786	6636
25635246	25068596
44	44
102540984	200274384
102540984	100274384
112.79508241	110.30182224

This

This which hath been done by the Table of Squares may be more easily performed, by the Table of the third part of the Areas of Circles, ready reduced to Wine-Gallons.

Spheroid	Parabolick Spindle.
1.16053	1.16053
0.54853	0.54853
1.70906	1.70906
85453	85453
30600	61200
2.86959	2.624790
44	44
1147836	1049916
1147836	10499160
126.26196	115.490760

Parabolick Conoid	Cone.
1.16053	1.16053
0.54853	0.54853
1.70906	1.70906
85453	85453
	56666
2.56359	2.506924
44	44
1025436	10027696
1025436	10027696
112.79796	110.304656

Examples

Examples in Ale-measure by the Table of the Squares of Numbers.

Spheroid.	Parabolick Spindle.
1024	1024
484	484
1508	1508
754	754
270	540
2532	2316.0
00092836	.00092836
22758	20844
5064	4632
20256	18528
7596	6948
15192	138960
235660752	2.150081760
44	44
948623008	860032704
940643008	860032704
103.22673088	94.60359744

Parabolick Conoid	Cone.
1024	1024
484	484
1508	1508
754	754
2262	50
20358·	2212
4524·	19909·
18096·	4424·
6786·	17696·
13527	6636·
	13272
2.09995032	2.05423232
44	44
8.39980128	821692928
839980128	821692928
92.39781408	90.38622208

By

By the Areas of Circles.

Spheroid.	Parabolick Spindle.
0.95052	0.95052
0.44930	0.44930
1.39982	1.39982
.69991	69991
.25061	050122
2.35034	2.149852
34	44
940136	8599408
940136	8599408
103.41496	94.598488

Parabolick

Parabolick Conoid.	Cone.
0.95052	0.95052
0.44930	0.44930
1.39982	1.39982
69991	.69991
	46425
209973	2.053305
44	44
839892	8213220
839892	8213220
90.345420	90.345420

And here for the Singularity of the Example, I will set the Dimensions of a Cask lately made in *Herefordshire*, for that excellent Liquor of Red streak Cyder, the like whereof either for the largeness of the Cask, or incomparable goodness of that kind of Drink, is not to be found in all *England*, nay and perhaps not in the World.

The length of the Cask is 104 Inches.
The Diameter at the Bung 92 Inches.
And the Diameter at the Head 74 Inches.

The

The Numbers in the Table of Ale-Gallons answering to these Dimensions are.

	Spheroid	Parabolick Spindle.
Bung.92	7.850639	7.850639
Head.74	5.083699	5.083699
	12.941338	12.941338
	6.470669	6.470569
	1.386770	.277394
	20.798777	19.689401
	104	104
	83195108	78.757604
	20798777	19689401
Con.	2163.072808	2047.697704

Parabolick

Parabolick Conoid.	Cone.
7.857639	7.857639
5.083699	5.083699
12.941338	12.941338
6.470669	6.470669
	0.150394
19.412007	19.261613
104	104
77648028	77046452
19412007	19261613
2018.848728	2003.207752

And thus you have the content of this Cask by four ſeveral Ways of Gauging, but that which doth beſt agree with the true content, found by theſe that filled the ſame is the ſecond way or that which takes a Cask to be the middle *Fruſtum* of a Parabolick Spindle, according to which the content is 2047 Gallons. That is allowing 64 Gallons to the Hogſhead. 32 Hogſheads very near.

Propoſition.

Proposition. X.

If a Cask be not full, to find the quantity of Liquor contained in it, the Axis being posited parallel to the Horizon.

To resolve this Proposition, there must be given the whole content of the Cask, the Diameter at the Bung, and the wet Portion thereof, then by help of the Table of Segments, whose Area is unity, and the Diameter divided into 10.000 equal parts, the content may thus be found.

As the whole Diameter, is to its wet Portion.

So is the Diameter in the Table. 10.000 to its like Portion, which being sought in the Table of Segments, gives you a Segment, by which if you multiply the whole content of the Cask, the Product is the content of the Liquor remaining in the Cask.

But in the Table of Segments in this Book, you have the Area, to the equal parts of one half of the Diameter only, when the Cask therefore is more then half full, you must make use of the dry part of the Diameter instead of the wet, so shall you find what quantity of Liquor is wanting to fill up the Cask, which being deducted from the whole content of the Cask; the remainer is the quantity of Liquor yet remaining, an Example in each will be sufficient, to explane the use of this Table.

1. *Example*, In a Wine Cask not half full, let the great Diameter be as before 32 Inches, the content

content 126.25 Gallons, and let the wet part of the Diameter be 12 Inches, First I say.

As the whole Diameter 32. is to the wet part 12. so is 10.000 to 3750, which being sought in the Table, I find, the Area of that Segment to be.342518 which being multiplyed by the whole content of the Cask 126.25, the Product is 43.2428975 0 and therefore there is remaining in the Cask 43 & ¼ fere.

2. Example. In the same Cask let the wet part of the Diameter be 18 Inches. I say.

As 32.18 :: 10000.5625 whose Complement to 10000 is 4375 which being sought in the Table, I find the Area answering thereto to be 420630; now then I say.

As the whole Area of the Circle 1000000 is to the whole content of the Cask 126.25.

So is the Area of the Segment sought.420630, to the content 53.1044375 which is in this case the content of the Liquor that is wanting, this therefore being deducted from the content of the whole Cask, 136.25. the part remaining in the Vessel is.73.1455625.

Thus may Casks be gauged in whole or in part, in which a Table of Squares is sometimes necessary, as being the Foundation, from whom the other Tables are deduced; such a Table therefore is here exhibited, for all Numbers under 1000, by help whereof the Square of any Number under 10.000 may easily be found in this manner.

The Rectangle made of the Sum and Difference of any two Numbers, is equal to the Difference of the Squares of these Numbers.

Example, Let the given Numbers be 36 and 85 their

their Sum is 121, their difference 49, by which if you multiply 121, the Product will be 5929. The Square of 36 is 1296, and the Square of 85 is 7225, the difference between which Squares is 5929 as before.

And hence the Square of any Number under 10.000 may thus be found, the Squares of all Numbers under 1000 being given.

Example. Let the Square of 5715 be required. The Square of 571 by the Table is 326041, therefore the Square of 5710 is 32604100: the Sum of 5710 and 5715 is 11425, and the difference 5, by which if you multiple 11425, the Product is 52125 which being added unto 32604100 the Sum 32656325 is the Square of 5715. The like may be done for any other.

Jas Burgess

TABLES

their Sum is 121, their difference 49, by which if you multiply 121, the Product will be 5929. The Square of 36 is 1296, and the Square of 85 is 7225, the difference between which Squares is 5929 as before.

And hence the Square of any Number under 10000 may thus be found, the Squares of all Numbers under 1000 being given.

Example. Let the Square of 5715 be required. The Square of 571 by the Table is 326041, therefore the Square of 5710 is 32604100: the Sum of 5710 and 5715 is 11425, and the difference 5, by which if you multiply 11425, the Product is 57125 which being added unto 32604100 the Sum 32661225 is the Square of 5715. The like may be done for any other.

TABLES

Jas. Burges

TABLES

FOR THE

Measuring

OF

TIMBER,

AND THE

GAUGING

OF

CASKS

AND

Brevvers Tuns.

LONDON,
Printed for *Thomas Passinger* at the three Bibles on *London-Bridge*, 1679.

John Mathe

James Burgess

1848

1	1		34	1156	69	67	4489	135
2	4	3	35	1225	71	68	4624	137
3	09	5	36	1296	73	69	4761	139
4	16	7	37	1369	75	70	4900	141
5	25	9	38	1444	77	71	5041	143
6	36	11	39	1521	79	72	5184	145
7	49	13	40	1600	81	73	5329	147
8	64	15	41	1681	83	74	5476	149
9	81	17	42	1764	85	75	5625	151
10	100	19	43	1841	87	76	5776	153
11	121	21	44	1936	89	77	5929	155
12	144	23	45	2025	91	78	6084	157
13	169	25	46	2116	93	79	6241	159
14	196	27	47	2209	95	80	6400	161
15	225	29	48	2304	97	81	6561	163
16	256	31	49	2401	99	82	6724	165
17	287	33	50	2500	101	83	6889	167
18	324	35	51	2601	103	84	7056	169
19	361	37	52	2704	105	05	7225	171
20	400	39	53	2809	107	06	7396	173
21	441	41	54	2916	109	87	7569	175
22	484	43	55	3025	111	88	7744	177
23	529	45	56	3136	113	89	7921	179
24	576	47	57	3249	115	90	8100	181
25	625	49	58	3364	117	91	8281	183
26	676	51	59	3481	119	92	8464	185
27	729	53	60	3600	121	93	8649	187
28	784	55	61	3721	123	94	8836	189
29	841	57	62	3844	125	95	9025	191
30	900	59	63	3969	127	96	9216	193
31	961	61	64	4096	129	97	9409	195
32	1024	63	65	4225	131	98	9604	197
33	1089	65	66	4356	133	99	9801	199
34	1156	67	67	4489	135	100	10000	201

101	10201	203	134	17956	269
102	10404	205	135	18225	271
103	10609	207	136	18496	273
104	10816	209	137	18769	275
105	11025	211	138	19044	277
106	11236	213	139	19321	279
107	11449	215	140	19600	281
108	11664	217	141	19881	283
109	11881	219	142	20164	285
110	12100	221	143	20449	287
111	12321	223	144	20736	289
112	12544	225	145	21025	291
113	12769	227	146	21316	293
114	12996	229	147	21609	295
115	13225	231	148	21904	297
116	13456	233	149	22201	299
117	13689	235	150	22500	301
118	13924	237	151	22801	303
119	14161	239	152	23104	305
120	14400	241	153	23409	307
121	14641	243	154	23716	309
122	14884	245	155	24025	311
123	15129	247	156	24336	313
124	15376	249	157	24649	315
125	15625	251	158	24964	317
126	15876	253	159	25281	319
127	16129	255	160	25600	321
128	16384	257	161	25921	323
129	16641	259	162	26244	325
130	16900	261	163	26569	327
131	17161	263	164	26896	329
132	17424	265	165	27225	331
133	17689	267	166	27556	333
134	17956	269	167	27889	335

167	27889	335	201	40401	403
168	28224	337	202	40804	405
169	28561	339	203	41209	407
170	28900	341	204	41616	409
171	29241	343	205	42025	411
172	29584	345	206	42436	413
173	29929	347	207	42849	415
174	30276	349	208	43264	417
175	30625	351	209	43681	419
176	30976	353	210	44100	421
177	31329	355	211	44521	423
178	31684	357	212	44944	425
179	32041	359	213	45369	427
180	32400	361	214	45796	429
181	32761	363	215	46225	431
182	33124	365	216	46656	433
183	33489	367	217	47089	435
184	33856	369	218	47524	437
185	34225	371	219	47961	439
186	34596	373	220	48400	441
187	34969	375	221	48841	443
188	35344	377	222	49284	445
189	35721	379	223	49729	447
190	36100	381	224	50176	449
191	36481	383	225	50625	451
192	36864	385	226	51076	453
193	37249	387	227	51529	455
194	37636	389	228	51984	457
195	38025	391	229	52441	459
196	38416	393	230	52900	461
197	38809	395	231	53361	463
198	39204	397	232	53824	465
199	39601	399	233	54289	467
200	40000	401	234	54756	469

234	54756	469	267	71289	535
235	55225	471	268	71824	537
236	55696	473	269	72361	539
237	56169	475	270	72900	541
238	56644	477	271	73441	543
239	57121	479	272	73984	545
240	57600	481	273	74529	547
241	58081	483	274	75076	549
242	58564	485	275	75625	551
143	59049	487	276	76176	553
244	59536	489	277	76729	555
245	60025	491	278	77284	557
246	60516	493	279	77841	559
247	61009	495	280	78400	561
248	61504	497	281	78961	563
249	62001	499	282	79524	565
250	62500	501	283	80089	567
251	63001	503	284	80616	569
252	63504	505	285	81225	571
253	64009	507	286	81796	573
254	64516	509	287	82369	575
255	65025	511	288	82944	577
256	65536	513	289	83521	579
257	66049	515	290	84100	581
258	66564	517	291	84681	583
259	67071	519	292	85264	585
260	67600	521	293	85849	587
261	68121	523	294	86436	589
262	68644	525	295	87025	591
263	69169	527	296	87616	593
264	69696	529	297	88200	595
265	70225	531	298	88804	597
266	70756	533	299	89401	599
277	71289	535	300	90000	601

301	090601	603	334	111556	669
302	091204	605	335	112225	671
303	091809	607	336	112896	673
304	092416	609	337	113569	675
305	093025	611	338	114244	677
306	093636	613	339	114921	679
307	094249	615	340	115600	681
308	094864	617	341	116281	683
309	095481	619	342	116964	685
310	096109	621	343	117649	687
311	096721	623	344	118336	689
312	97344	625	345	119025	691
313	97969	627	346	119716	693
314	98596	629	347	120409	695
315	99325	631	348	121104	697
316	99856	633	349	121801	699
317	100487	645	350	122500	701
318	101124	637	351	123201	703
319	101761	639	352	123904	705
320	102400	641	353	124609	707
321	103041	643	354	125316	709
322	103684	645	355	126025	711
323	104329	647	356	126736	713
324	104976	649	357	127449	715
325	105625	651	358	128164	717
326	106276	653	359	128881	719
327	106929	655	360	129600	721
328	107584	657	361	138321	723
329	108241	659	362	131044	725
330	108900	661	363	131769	727
331	109561	663	364	132496	729
332	110224	665	365	133225	731
333	110889	667	366	133956	733
334	111556	669	367	134689	735

367	134689	735	401	160801	803
368	135424	737	402	161604	805
369	136161	739	403	162409	807
370	136900	741	404	163216	809
371	137641	743	405	164025	811
372	138384	745	406	164836	813
373	139129	747	407	165649	815
374	139876	749	408	166464	817
375	140625	751	409	167281	819
376	141376	753	410	168100	821
377	142129	755	411	168921	823
378	142884	757	412	169744	825
379	143641	759	413	170569	827
380	144400	761	414	171396	829
381	145161	763	415	172225	831
382	145924	765	416	173056	833
383	146689	767	417	173889	835
384	147456	769	418	174724	837
385	148225	771	419	175561	839
386	148996	773	420	176400	841
387	149769	775	421	177241	843
388	150544	777	422	178084	845
389	151321	779	423	178929	847
390	152100	781	424	179776	849
391	152881	783	425	180625	851
392	153664	785	426	181476	853
393	154449	787	427	182329	855
394	155236	789	428	183184	857
395	156025	791	429	184041	859
396	156816	793	430	184900	861
397	157609	795	431	185761	863
398	158404	797	432	186624	865
399	159201	799	433	187489	867
400	160000	801	434	188356	869

434	188356	869	467	218089	935
435	189225	871	468	219024	937
436	190096	873	469	219961	939
437	190969	875	470	220900	941
438	191844	877	471	221841	943
439	192721	879	472	222784	945
440	193600	881	473	223729	947
441	194481	883	474	224676	949
442	195364	885	475	225625	951
443	196249	887	476	226576	953
444	197136	889	477	227529	955
445	198025	891	478	228484	957
446	198916	893	479	229441	959
447	199809	895	480	230400	961
448	200704	897	481	231361	963
449	201601	899	482	232324	965
450	202500	901	483	233289	967
451	203401	903	484	234256	969
452	204304	905	485	235225	971
453	205209	907	486	236196	973
454	206116	909	487	237169	975
455	207025	911	488	238144	977
456	207936	913	489	239121	979
457	208849	915	490	240100	981
458	209764	917	491	241081	983
459	210681	919	492	242064	985
460	211600	921	493	243049	987
461	212521	923	494	244036	989
462	213444	925	495	245025	991
463	214369	927	496	246016	993
464	215296	929	497	247009	995
465	216225	931	498	248004	997
466	217156	933	499	249001	999
467	218089	935	500	250000	1001

501	251001	1003
502	252004	1005
503	253009	1007
504	254016	1009
505	255025	1011
506	256036	1013
507	257049	1015
508	258064	1017
509	259081	1019
510	260100	1021
511	261121	1023
512	262144	1025
513	263169	1027
514	264196	1029
515	265225	1031
516	266256	1033
517	267289	1035
518	268324	1037
519	269361	1039
520	270400	1041
521	271441	1043
522	272484	1045
523	273529	1047
524	274576	1049
525	275625	1051
526	276676	1053
527	277729	1055
528	278784	1057
529	279841	1059
530	288900	1061
531	281961	1063
532	283024	1065
533	284089	1067
534	285156	1069

534	285156	1069
535	286225	1071
536	287296	1073
537	288369	1075
538	289444	1077
539	290521	1079
540	291600	1081
541	292681	1083
542	293764	1085
543	294849	1087
544	295936	1089
545	297025	1091
546	298116	1093
547	299209	1095
548	300324	1097
549	301401	1099
550	302500	1101
551	303601	1103
552	304704	1105
553	305809	1107
554	306916	1109
555	308025	1111
556	309136	1113
557	310249	1115
558	311364	1117
559	312481	1119
560	313600	1121
561	314721	1123
562	315844	1125
563	316969	1127
564	318096	1129
565	319225	1131
566	320356	1133
567	321489	1135

567	321489	1135	601	361201	1203
568	322624	1137	602	362404	1205
569	323761	1139	603	963609	1207
570	324900	1141	604	364816	1209
571	326041	1143	605	366025	1211
572	327184	1145	606	367236	1213
573	328329	1147	607	368449	1215
574	329476	1149	608	369664	1217
575	330625	1151	609	370881	1219
576	331776	1153	610	372100	1221
577	332929	1155	611	373321	1223
578	334084	1157	612	374544	1225
579	335241	1159	613	375769	1227
580	336400	1161	614	376996	1229
581	337561	1163	615	378225	1231
582	338724	1165	616	379456	1233
583	339889	1167	617	380689	1235
584	341056	1169	618	381924	1237
585	342225	1171	619	383161	1239
586	343396	1173	620	384400	1241
587	344569	1175	621	385641	1243
588	345744	1177	622	386834	1245
589	346921	1179	623	388129	1247
590	348100	1181	624	389376	1249
591	349281	1183	625	390625	1251
592	350464	1185	626	391876	1253
593	351649	1187	627	393129	1255
594	352836	1189	628	394385	1257
595	354025	1191	629	395641	1259
596	355216	1193	630	396900	1261
597	356409	1195	631	398161	1263
598	357604	1197	632	399424	1265
599	358801	1199	633	400689	1267
600	369000	1201	634	401956	1269

634	401956	1269	667	444889	1335
635	403225	1271	668	446224	1337
636	404496	1273	669	447561	1339
637	405769	1275	670	448900	1341
638	407044	1277	671	450241	1343
639	408321	1279	672	451584	1345
640	409600	1281	673	452929	1347
641	410881	1283	674	454276	1349
642	412164	1285	675	455625	1351
643	413449	1287	676	456976	1353
644	414736	1289	677	458329	1355
645	416025	1291	678	459684	1357
646	417316	1293	679	461041	1359
647	418609	1295	680	462400	1361
648	419904	1297	681	463761	1363
649	421201	1299	682	465124	1365
650	422500	1301	683	466489	1367
651	423801	1303	684	467856	1369
652	425104	1305	685	469225	1371
653	426409	1307	686	470596	1373
654	427716	1309	687	471969	1375
655	429025	1311	688	473344	1377
656	430336	1313	689	474721	1379
657	431649	1315	690	476100	1381
658	432964	1317	691	477481	1383
659	434281	1319	692	478864	1385
660	435600	1321	693	480249	1387
661	436921	1323	694	481636	1389
662	438244	1325	695	483025	1391
663	439569	1327	696	484416	1393
664	440896	1329	697	485809	1395
665	442225	1331	698	487204	1397
666	443556	1333	699	488601	1399
667	444889	1335	700	490000	1401

701	491401	1403
702	492804	1405
703	494209	1407
704	495616	1409
705	497025	1411
706	498436	1413
707	499849	1415
708	501264	1417
709	502681	1419
710	504100	1421
711	505521	1423
712	506944	1425
713	508369	1427
714	509796	1429
715	511225	1431
716	512656	1433
717	514089	1435
718	515524	1437
719	516961	1439
720	518400	1441
721	519841	1443
722	521284	1445
723	522729	1447
724	524176	1449
725	525625	1451
726	527076	1453
727	528529	1455
728	529984	1457
729	531441	1459
730	532900	1461
731	534361	1463
732	535824	1465
733	537289	1467
734	538756	1469

734	538756	1469
735	540225	1471
736	541696	1473
737	543169	1475
738	544644	1477
739	546121	1479
740	547600	1481
741	549081	1483
742	550564	1485
743	552049	1487
744	553536	1489
745	555025	1491
746	556516	1493
747	558009	1495
748	559504	1497
749	561001	1499
750	562500	1501
751	564001	1503
752	565504	1505
753	567009	1507
754	568516	1509
755	570025	1511
756	571536	1513
757	573049	1515
758	574564	1517
759	576081	1519
760	577600	1521
761	579121	1523
762	580644	1525
763	582169	1527
764	583696	1529
765	585225	1531
766	586756	1533
767	588289	1535

767	588289	1535	801	641601	1603
768	589824	1537	802	643204	1605
769	591361	1539	893	644809	1607
770	592900	1541	804	646416	1609
771	594441	1543	805	648025	1611
772	595984	1545	806	649636	1613
773	597529	1547	807	651249	1615
774	599076	1549	808	652864	1617
775	600625	1551	809	654481	1619
776	602176	1553	010	656100	1621
777	603726	1555	811	657721	1623
778	605284	1557	812	659344	2625
779	606841	1559	813	560969	1627
780	608400	1561	814	562596	1629
781	609961	1563	815	564225	1631
782	611524	1565	816	565856	1633
783	613089	1567	817	567489	1635
784	614656	1569	818	569124	1637
785	616225	1571	819	570761	1639
786	617796	1573	820	672400	1641
787	619369	1575	821	674041	1643
788	620944	1577	822	675684	1645
789	622521	1579	823	677329	1647
790	624100	1581	824	678976	1649
791	625681	1583	825	680625	1651
792	627264	1585	826	682276	1653
793	628849	1587	827	683929	1655
794	630436	1589	828	685584	1657
795	632025	1591	829	687241	1659
796	633616	1593	830	688900	1661
797	635209	1595	831	690561	1663
798	636804	1597	832	692224	1665
799	638401	1599	833	693889	1667
800	640000	1601	834	695556	1669

834	695556	1669
835	697225	1671
836	668869	1673
837	700569	1675
838	702244	1677
839	703921	1679
840	705600	1681
841	707281	1683
842	708964	1685
853	710649	1687
844	712336	1689
845	714025	1691
846	715716	1693
847	717409	1695
848	719104	1697
849	729801	1699
850	722500	1701
851	724201	1703
852	725904	1705
853	727609	1707
854	729316	1709
855	731025	1711
856	732736	1713
857	734449	1715
858	736164	1717
859	737881	1719
860	739600	1721
861	741321	1723
862	743044	1725
863	744769	1727
864	746596	1729
865	748225	1731
866	749956	1733
867	751689	1735
867	751689	1735
868	753424	1737
869	755161	1739
870	756900	1741
871	658641	1743
872	760384	1745
873	762129	1747
874	763876	1749
875	765625	1751
876	767376	1753
877	769529	1755
878	770884	1757
879	772641	1759
880	774400	1761
881	776161	1763
882	777924	1765
883	779689	1767
884	781456	1769
885	783225	1771
886	754996	1773
887	786709	1775
888	786544	1777
889	790321	1779
890	792100	1781
891	793881	1783
892	795664	1785
893	797449	1787
894	799236	1789
895	801025	1791
896	802816	1793
897	894609	1795
808	806404	1797
899	808281	1799
900	810000	1801

901	811801	1803	934	872356	1869
902	813604	1805	935	874225	1871
903	815409	1807	936	876096	1873
904	817216	1809	937	877969	1875
905	819025	1811	938	879844	1877
906	820836	1813	939	881721	1879
907	822649	1815	940	883600	1881
908	824464	1817	941	885481	1883
909	826281	1819	942	887364	1885
910	828100	1821	943	889249	1887
911	829921	1823	944	891136	1889
912	831744	1825	945	893025	1891
913	833569	1827	946	894916	1893
914	835396	1829	947	896809	1895
915	837225	1831	948	898704	1897
916	839056	1833	949	900601	1899
917	840889	1835	950	902500	1901
918	842724	1837	951	904401	1903
919	844561	1839	952	906304	1905
920	846400	1841	953	908209	1907
921	848241	1843	954	910116	1909
922	850084	1845	955	912025	1911
923	851929	1847	956	913936	1913
924	853776	1849	957	915849	1915
925	855625	1851	958	917764	1917
926	857476	1853	959	919681	1919
927	859329	1855	960	921600	1921
928	861184	1857	961	923521	1923
929	863041	1859	962	925444	1925
930	864900	1861	963	927369	1927
931	866761	1863	964	929296	1929
932	868624	1865	965	931225	1931
933	870489	1867	966	933156	1933
934	872356	1869	967	935089	1935

967	935089	1935	984	968256	1969
968	937024	1937	985	970225	1971
969	938961	1939	986	972196	1973
970	940900	1941	987	974169	1975
971	942841	1943	988	976144	1977
972	944784	1945	989	978121	1979
973	946729	1947	990	980100	1981
974	948676	1949	991	982081	1983
975	950625	1951	992	984064	1985
976	952576	1953	993	986049	1987
977	954529	1955	994	988036	1989
978	956484	1957	995	990025	1991
979	958441	1959	996	992016	1993
980	960400	1961	997	994009	1995
981	962361	1963	998	996004	1997
982	964324	1965	999	998001	1999
983	966289	1967	1000	1000000	2001

	0	1	2	3	4
1	0. 001133	001371	001631	001915	002221
2	0. 004533	004997	005485	005995	006527
3	0. 010199	010891	011605	012341	013101
4	0. 018133	019051	019991	020955	021941
5	0. 028333	029477	030645	031835	033047
6	0. 040799	042171	043565	044981	046421
7	0. 051533	057131	058751	060395	062061
8	0. 072533	074357	076205	078075	079967
9	0. 091799	093851	095925	098021	100141
10	0. 113333	115610	117911	120234	122580
11	0. 137132	139637	142164	144714	147287
12	0. 163199	165930	168684	171461	174260
13	0. 191532	194490	197471	200474	203500
14	0. 222132	225317	228524	231754	235007
15	0. 254999	258410	261844	265301	268780
16	0. 290132	293770	297431	301114	304820
17	0. 327532	331397	335284	339194	343126
18	0. 367198	371290	375404	379540	383700
19	0. 409132	413450	417790	422154	426540
20	0. 453332	457876	462443	467033	471646
21	0. 499798	504569	509363	514180	519019
22	0. 548531	553529	558550	563593	568659
23	0. 599531	604756	610003	615273	620566
24	0. 652798	658249	663723	669220	674739
25	0. 708331	714009	719709	725233	731179
26	0. 766131	772035	777963	783913	789885
27	0. 826197	832328	838482	844659	850858
28	0. 888530	894888	901269	907672	914098
29	0. 953130	959715	966322	972952	979605
30	1. 019997	026808	033642	040498	047378
31	1. 089130	096168	103228	110312	117418
32	1. 160529	167794	175081	182391	189724
33	1. 234196	241687	249201	256738	264297
34	1. 310129	317847	325588	333351	341137

5	6	7	8	9	
002549	002901	003275	003671	004091	
007083	007661	008261	008885	009531	
013883	014687	015515	016365	017237	
022949	023981	025035	026111	027211	
034283	035541	036825	038125	039451	
047883	049367	050875	052405	053957	
063749	065461	067195	068951	070731	
081883	083821	085781	087765	089771	
102283	104447	106635	108845	111077	
124949	127340	129754	132191	134650	
149882	152500	155141	157804	160490	
177082	179927	182794	185684	188597	
206549	229620	212714	215831	218970	
238282	241589	244901	248244	251610	
272282	275807	279354	282924	286517	
308549	312300	316074	319871	323690	
347082	351060	355060	359084	363130	
387882	392086	396314	400564	404836	
430948	435380	439834	444310	448810	
476281	480939	485620	490323	495049	
523881	528766	533673	538603	543556	
573748	578859	583993	589150	594329	
625881	631219	636580	641963	647369	
680281	685845	691433	697043	702675	
736947	742739	748553	754389	760249	
795880	801898	807939	814002	820088	
857080	863325	869592	875882	882195	
920547	927018	933512	940029	946568	
986280	992978	999699	006442	013208	
054280	061204	068152	075122	082114	
124546	131698	138871	146068	153287	
197079	204457	211858	219281	226727	
271879	279484	287111	294761	302434	
348946	356777	364631	372507	380467	

	0	1	2	3	4
34	1. 310129	317847	325588	333351	341137
35	1. 388329	396273	404241	412231	420243
36	1. 468795	476966	485160	493377	501616
37	1. 551528	559926	568347	576790	585256
38	1. 636528	645153	653800	662470	671163
39	1. 723794	732646	741520	750416	759336
40	1. 813328	822405	831506	840629	849775
41	1. 905127	914432	923759	933109	942482
42	1. 999194	008725	018279	027856	037455
43	2. 095527	105285	115065	124869	134695
44	2. 194126	204111	214118	224148	234201
45	2. 294993	305204	315438	325695	335974
46	2. 398126	408564	419024	429508	440014
47	2. 503525	514190	524877	535587	546320
48	2. 611192	622083	632997	643934	654893
49	2. 721125	732243	743383	754547	765733
50	2. 833325	844669	856036	867426	878839
51	2. 947791	959362	970956	982573	994212
52	3. 064524	076322	088142	099986	111852
53	3. 183523	195548	207595	219665	231758
54	3. 304790	317041	329315	341612	353931
55	3. 428323	440801	453301	465825	478371
56	3. 554122	566827	579554	592304	605077
57	3. 682189	695120	708074	721051	734050
58	3. 812522	825680	838860	852064	865289
59	3. 945121	958506	971913	985343	998796
60	4. 079988	093599	107233	120889	134[illegible]69
61	4. 217120	230958	244819	258702	272608
62	4. 356520	370585	384672	398782	412915
63	4. 498186	512478	526792	541128	555487
64	4 642119	656637	671178	685741	700327
65	4. 788319	80[illegible]06[illegible]	81[illegible]831	822621	847433
66	4. 936785	951756	966750	9817[illegible]7	996806
67	5. 087518	[illegible]02716	117936	133180	148446

5	6	7	8	9
348946	356777	364631	372507	380467
428279	436337	444417	452521	460647
509878	518163	526470	534800	543153
593745	602256	610790	619347	627926
679878	688616	697577	706160	714966
768278	777242	786230	795240	804272
858944	868135	877349	886586	895845
951877	961295	970736	980199	989685
047077	056721	066389	076079	085791
144543	154414	164308	174225	184164
244276	254374	264495	274638	284804
346276	356601	366948	377318	387710
450542	461094	471668	482264	492884
557075	567853	578654	589477	600323
665875	676880	697907	698957	710030
776941	788173	799427	810703	822003
890274	901732	913213	924716	936242
005874	017559	029266	040996	052749
123740	135652	147586	159542	171522
243872	256011	268172	280355	292561
366273	378638	391025	403435	415867
490939	503531	516544	528781	541440
617872	630690	643531	856394	669280
747072	760116	773184	786274	799386
878530	891809	905103	918420	931759
012271	025769	039290	052833	066399
148271	161195	175743	189513	203305
286537	300488	314462	328459	342478
427070	441248	455448	469672	483918
569869	584274	598701	613151	627624
714936	729567	744221	758898	773597
862269	877126	892007	906910	921836
011868	026953	042060	057190	072341
163734	179046	194380	209736	225115

	0	1	2	3	4
67	5. 087518	102716	117936	133180	148446
68	5. 240517	255942	271389	286859	302352
69	5. 395784	411435	427109	442805	458525
70	5. 553317	569194	585095	601018	616964
71	5. 713116	729221	745348	761498	777601
72	5. 875182	891514	907867	924244	940643
73	6. 039555	056073	072654	089257	105883
74	6. 206115	222899	239706	256536	273389
75	6. 374981	391992	409026	426083	443162
76	6. 546114	563352	580612	597895	615201
77	6. 719513	736978	754465	771975	789508
78	6. 895179	912871	930584	948321	966080
79	7. 073112	091030	108971	126934	144920
80	7. 253312	271456	289623	307813	326026
81	7. 455778	454149	472543	490959	509399
82	7. 620510	639108	657729	676372	695038
83	7. 807510	826334	845182	864052	882944
84	7. 996776	015827	034901	053998	073117
85	8. 188309	207587	226887	246211	265557
86	8. 382108	401613	421140	440690	460263
87	8. 578174	597906	617659	637436	657235
88	8. 776507	796465	816446	836449	856475
89	8. 977106	997291	017498	037728	057981
90	9. 179973	200384	220818	241274	261754
91	9. 385105	405743	426404	447087	467793
92	9. 592505	613369	634256	655166	676099
93	9. 802171	823262	844376	865512	886672
94	10. 014103	035421	056762	078125	099511
95	10. 228303	249847	271415	293005	314617
96	10. 444769	466540	488334	510151	531990
97	10. 663501	685499	707520	729563	751629
98	10. 884501	906725	928973	951243	973535
99	11. 107767	130218	152692	175189	197708
100	11. 333300				

5	6	7	8	9
163734	179046	194380	209736	225115
317567	333405	348966	364549	380155
474267	490031	505819	521629	537461
632933	648924	664938	680975	697034
793868	810084	826324	842588	858874
957065	973510	989977	006467	022980
122531	139203	155897	172613	189353
290264	307162	324083	341026	357992
460264	477388	494536	511706	528898
632530	649881	667255	684652	702071
807063	824641	842241	859865	877511
983862	001667	019494	037344	055217
162928	180960	199012	217090	235190
344261	362519	380800	399103	417429
527861	546345	564853	583383	601935
713727	732438	751172	769929	788708
901860	920798	939758	958741	977747
092259	111424	130611	149821	169053
284925	304316	323730	343167	362626
479858	499476	519116	538780	558466
677057	696902	716769	736659	756572
876523	896595	916689	936805	936944
078256	098554	118875	139218	159584
282256	302780	323327	343897	364490
488522	509273	530047	550843	571663
897054	718032	739033	760056	781102
907854	929058	950286	971536	992808
120920	142351	163805	185282	206781
336252	357910	379591	401294	423020
553852	575736	597644	619574	641526
773718	795829	817963	840120	862299
995850	018188	040549	062932	085338
220250	242814	265402	288012	310644

	0	1	2	3	4
1	0. 000928	001127	001336	001569	001819
2	0. 003713	004094	004493	004911	005347
3	0. 008355	008921	009506	010109	010731
4	0. 014855	015605	016376	017165	017973
5	0. 023209	024146	025102	026077	027070
6	0. 033420	034544	035686	036846	038025
7	0. 045489	046798	048126	049472	050836
8	0. 059415	060909	062422	063954	065505
9	0. 075197	076877	078576	080293	082029
10	0. 092836	094702	096586	098489	100411
11	0. 112331	114383	116453	118542	120649
12	0. 133683	135921	138177	140451	142744
13	0. 156892	159315	161757	164217	166696
14	0. 181958	184567	187194	189840	192504
15	0. 208881	211675	214488	217319	220169
16	0. 237660	240640	243638	246655	249691
17	0. 268296	271461	274646	277848	281070
18	0. 300788	304140	307509	310898	314305
19	0. 335137	338675	342230	345804	349397
20	0. 371344	375066	378808	382567	386346
21	0. 409406	413315	417242	421187	425151
22	0. 449326	453420	457532	461664	465813
23	0. 491102	495382	499680	503997	508338
24	0. 534735	539200	543684	548187	552708
25	0. 580225	584876	589545	594233	598940
26	0. 627570	632408	637263	642137	647029
27	0. 676774	681796	686837	691897	696975
28	0. 727834	733042	738269	743514	748778
29	0. 780750	786144	791556	796987	802437
30	0. 835524	841103	846701	852318	857953
31	0. 892133	897919	903702	909505	915325
32	0. 950640	956591	962560	968548	974555
33	1. 010984	017120	023275	029449	035641
34	1. 073184	079506	085846	092206	098584

5	6	7	8	9	
002089	002376	002683	003008	003351	
005802	006275	006767	007278	007807	
011372	012031	012709	013405	014120	
018799	019644	020507	021389	022289	
028082	029113	030162	031230	032316	
039223	040439	041674	042937	044199	
052220	053322	055042	056481	057938	
067074	068661	070267	071892	073535	
083784	085557	087349	089159	090988	
102351	104310	106287	108283	110298	
122775	124920	127083	129264	131465	
145056	147386	149735	152102	154489	
169193	171709	174243	176796	179368	
195187	197889	200609	203347	206105	
223038	225925	228831	231755	234698	
252746	255818	258910	262020	265148	
284310	287568	290845	294141	297455	
317731	321175	324638	328119	331619	
353008	356638	360287	363954	367639	
390143	393958	397792	401645	405516	
429134	433135	437155	441193	445250	
469982	474169	478374	482598	486841	
512686	517059	521450	525860	530288	
557248	561806	566383	570978	575592	
603666	608410	613172	617953	622753	
651940	656870	661818	666785	671770	
702072	707187	712321	717473	722644	
754060	759361	764680	770018	775375	
807905	813391	818897	824420	829963	
863606	869279	874970	880679	886407	
921165	927023	932899	938794	944708	
980580	986623	992686	998766	004866	
041852	048081	054329	060595	066880	
104980	111395	117828	124281	130751	

	0	1	2	3	4
34	1.073184	079506	085846	092206	098584
35	1.137241	143748	150275	156820	163383
36	1.203154	209848	216560	223290	230039
37	1.270924	277803	284701	291617	298852
38	1.340551	347616	354700	361802	368922
39	1.412035	419286	426555	433842	441148
40	1.485376	492812	500266	507740	515232
41	1.560573	568194	575835	583494	591171
42	1.637627	645434	653260	661105	668968
43	1.716537	724530	732542	740572	748621
44	1.797304	805483	813681	821897	830131
45	1.879929	888293	896676	905078	913498
46	1.964409	972959	981528	990116	998721
47	2.050747	059483	068237	077010	085802
48	2.138941	147862	156803	165761	174739
49	2.228992	238099	247225	256369	265532
50	2.32090	330192	339504	348834	358182
51	2.414664	424142	433640	443155	452689
52	2.510285	519949	529632	539333	549053
53	2.607763	617613	627481	637368	647274
54	2.707097	717133	727187	737260	747351
55	2.808289	818510	828750	839008	849285
56	2.911336	921743	932169	942613	953076
57	3.016241	026834	037445	048075	058723
58	3.123003	133781	144578	155393	166227
59	3.231621	242585	253567	264568	275588
60	3.342096	353245	364413	375600	386805
61	3.454427	465762	477116	488489	499880
62	3.568615	580136	591676	603234	614811
63	3.684660	696367	708092	719836	731598
64	3.802562	814454	826365	838295	850243
65	3.922321	934398	946495	958610	970744
66	4.043936	056199	068481	080782	093102
67	4.167408	179857	192325	204811	217316

5	6	7	8	9	
104980	111395	117828	124281	130751	
169965	176566	183185	189823	196479	
236807	243593	250398	257222	264064	
305506	312478	319468	326477	333505	
376061	383219	390395	397590	404803	
448473	455817	463178	470549	477958	
522742	530271	537819	545385	552969	
598868	606582	614315	622067	629838	
676850	684750	692669	700606	708563	
756689	764775	772879	781002	789144	
838384	846656	854946	863255	871583	
921937	930394	938870	947365	955878	
007346	015989	024651	033331	042029	
094612	103440	112288	121154	130038	
183734	192749	201782	210833	219903	
274714	283914	293132	302369	311625	
267550	376935	386340	395762	405204	
462242	471814	481404	491012	508639	
558792	568549	578324	588119	597931	
657198	667141	677102	687082	697080	
757461	767589	777736	787902	798086	
859580	869894	880227	890578	900948	
963557	974056	984575	995112	005667	
069390	080075	090779	101502	112243	
177080	187951	198840	209748	220675	
286626	297683	308758	319852	330964	
398029	409272	420533	431812	443110	
511289	522717	534164	545629	557113	
626406	638020	649652	661303	672972	
743379	755179	766997	778838	790688	
862209	874194	886198	898220	910261	
982896	995067	007256	919464	031691	
105440	117796	130171	142565	154977	
229840	242382	254943	267522	280120	

	0	1	2	3	4
67	4.167408	179857	192325	204811	217316
68	4.292736	305371	318025	330697	343387
69	4.419921	432742	445581	458439	471315
70	4.548964	561970	574995	588038	601100
71	4.679862	693054	706265	819494	732724
72	4.812618	825995	839392	852806	866240
73	4.947230	960793	974375	987976	001595
74	5.083699	097448	111215	125002	138806
75	5.222025	235959	249912	263884	277875
76	5.362207	376327	390466	404624	418800
77	5.504246	518552	532877	547220	561581
78	5.648142	662633	677144	691673	706220
79	5.793894	808572	823268	837982	852715
80	5.941504	956367	971248	986148	001067
81	6.090969	106018	121085	136171	151276
82	6.242292	257527	272779	288051	303341
83	6.395472	410892	426330	441787	457263
84	6.550508	566113	581738	597381	613042
85	6.707401	723192	739002	754830	770678
86	6.866150	882127	898123	914137	930170
87	7.026756	042919	059100	075300	091519
88	7.189219	205568	221935	239320	254724
89	7.353539	370073	386626	403197	419787
90	7.519716	536435	553174	569930	586706
91	7.687749	704654	721578	738521	755482
92	7.857639	874730	891839	908968	926114
93	8.029385	046662	063957	081271	098604
94	8.202988	220451	237932	255432	272950
95	8.378449	396097	413763	431449	449152
96	8.555765	573599	591451	609322	627212
97	8.734939	752958	770996	789053	807128
98	8.915969	934174	952398	970640	988901
99	9.098856	117247	135656	154084	172531
100	9.283600	302176	320771	339385	358017

5	6	7	8	9	
229840	242382	254943	267522	280122	
356097	368825	381571	394336	407119	
484210	497124	510056	523007	535976	
614181	627280	640398	653534	666789	
746008	759293	772596	785918	799259	
879692	893162	906651	920159	933685	
015232	028888	042563	056257	069968	
152630	166471	180332	194211	208108	
291884	305911	319957	334022	348105	
432994	447208	461439	475690	489958	
575962	590361	604778	619214	633669	
720786	735370	749974	764595	779235	
867467	882237	897026	911833	926659	
016004	030960	045935	060928	075939	
166399	181540	196700	211879	227076	
318650	333977	349323	364687	380070	
472758	488270	503802	519352	534920	
628722	644421	660138	675873	691628	
786543	802427	818330	834252	850192	
946221	962291	978380	994487	010612	
107756	124011	140285	156578	172889	
271147	287588	304048	320527	337024	
436395	453022	469668	486332	503014	
603500	620313	637144	653993	670862	
772462	789460	806477	823512	840566	
943280	960464	977666	994887	012127	
115955	133324	150713	168119	185545	
290486	308042	325616	343208	360819	
466875	484616	502375	520153	537950	
645120	663047	680992	698956	716938	
825222	843334	861465	879614	897782	
007180	025478	043795	062130	080484	
190996	209479	227981	246502	265042	
376668	395337	414025	432731	451456	

	0	1	2	3	4
100	9. 283600	302176	302771	339385	358017
101	9. 470200	488962	507743	526524	545360
102	9. 658657	677605	696574	715556	734560
103	9. 848971	868104	887256	906427	925616
104	10. 041141	060460	079798	099154	118529
105	10. 235169	254673	274197	293739	323299
106	10. 431052	450743	470452	490180	509926
107	10. 628793	648669	668564	688477	708409
108	10. 828391	848452	868533	888632	908749
109	11. 029845	050092	070358	090643	110946
110	11. 233156	253589	274040	294511	315000
111	11. 438323	458942	479579	500235	520910
112	11. 645347	666152	686975	707817	728677
113	11. 854228	875219	896227	917255	938301
114	12. 064966	086142	107336	128549	149781
115	12. 277561	298922	320302	341701	363118
116	12. 492012	513559	535125	556709	578312
117	12. 708320	730052	751804	773574	795363
118	12. 926484	948403	970340	992296	014270
119	13. 146505	168610	190733	212874	235034
120	13. 368384	390673	412982	435309	457655
121	13. 592118	614594	637088	659601	682132
122	13. 817710	840371	863051	885749	908466
123	14. 045158	068005	090870	113754	136657
124	14. 274463	297495	320547	343616	366705
125	14. 505625	528843	552080	575335	598609
126	14. 738643	762047	785469	808910	832370
127	14. 973518	997108	020716	044343	067988
128	15. 210250	234025	257819	281631	305462
129	15. 448838	472799	496779	520777	544794
130	15. 689284	713430	737595	761779	785981
131	15. 931585	955918	982269	004638	029026
132	16. 175744	200262	224799	249354	273927
133	16. 421760	446463	471185	495926	520686

5	6	7	8	9	
376668	395337	414025	432731	451456	
564196	583051	601925	620817	639728	
753582	772622	791682	810759	829856	
944824	964050	983295	002559	021841	
137923	157335	176765	196215	215682	
332878	352476	372092	391727	411381	
529691	549474	569276	589096	608936	
728360	748329	768316	788323	808347	
928886	949040	969213	989405	009616	
131268	151668	171967	192345	212741	
335507	356033	376578	397141	417723	
541603	562315	583045	603794	624561	
749556	770453	791369	812304	833257	
959365	980448	001550	022670	043809	
171031	192300	213587	234893	256218	
384554	406008	427481	448973	470483	
509934	621574	643232	664909	686605	
817170	838995	860840	882703	904584	
036263	058274	080304	102353	124420	
257212	279409	301625	323859	346112	
480019	502402	524803	547223	569661	
704682	727250	749837	772443	795067	
931202	953956	976729	999520	022320	
159578	182518	205476	228453	251449	
389812	412937	436081	459244	482425	
621902	645213	668542	691891	715257	
855848	879345	902860	926394	949947	
091652	115334	139035	162755	186493	
329312	353180	377067	400972	424896	
568829	592883	616955	641046	665155	
810202	834442	858700	882977	907272	
053433	077858	102302	126764	151245	
298520	323131	347760	372408	497074	
545464	570260	595075	619909	644761	

	0	1	2	3	4
134	16. 669632	694521	719429	744355	769300
135	16. 919361	944436	969529	994641	019772
136	17. 170946	196207	221486	246784	272100
137	17. 424388	449835	475300	500783	526285
138	17. 679627	705319	730970	756639	782327
139	17. 936843	962661	988497	014352	040225
140	18. 195856	221859	247881	273921	299980
141	18. 456725	482914	509121	535347	561592
142	18. 719451	745825	772219	798630	825061
143	18. 984033	010059	037172	063770	090386
144	19. 250472	277219	303983	330766	357568
145	19. 518769	545700	572651	599619	626607
146	19. 788921	816039	843175	870329	897502
147	20. 060931	088234	115555	142896	170254
148	20. 334797	362286	389793	417319	444863
149	20. 610520	638194	665887	693599	721329
150	20. 888100	915960	943838	971735	999651
151	21. 167536	195582	223646	251729	279830
152	21. 448829	477060	505310	533579	561866
153	21. 731979	760396	788832	817286	845759
154	22. 016985	045588	074209	102849	131508
155	22. 303849	332637	361444	390270	419114
156	22. 592568	621543	650535	679547	708576
157	22. 883145	912305	941483	970680	999896
158	23. 175579	204924	234288	263671	293072
159	23. 469869	499400	528949	558515	588105
160	23. 766016	795732	825468	855222	884994
161	24. 064019	093922	123843	153782	183740
162	24. 363879	393967	424074	454199	484343
163	24. 665596	695870	726163	756474	786803
164	24. 969170	999630	030108	060604	091119
165	25. 274601	305246	335909	366592	397293
166	25. 581888	612718	643568	674436	705322
167	25. 89103[illegible]	922048	95308	984137	915209

5	6	7	8	9	
794264	819242	844247	869266	894304	
044921	070089	095275	120489	145704	
297435	322789	348161	373551	398961	
551806	577345	602903	628479	654074	
808033	833758	859501	885263	911044	
066117	092028	117957	143904	169871	
326058	352154	378269	404402	430554	
587856	614137	640438	666757	693094	
851510	877977	904463	930968	957491	
117021	143674	170346	197036	223745	
384388	411227	438085	464961	491855	
653613	680637	707680	734742	761822	
924694	951904	979133	006380	033646	
197632	225028	252442	279875	307327	
472426	500008	527608	555227	582864	
749078	776845	804631	832435	860258	
027586	055539	083510	111500	139509	
307950	336089	364246	392422	420616	
590172	618496	646839	675200	703580	
874250	902760	931288	959835	988401	
130185	188880	217595	246327	275079	
447976	476858	505758	534676	563613	
737625	766692	795777	824881	854004	
029130	058382	087654	116943	146252	
322492	351930	381387	410862	440356	
617710	647334	676976	706638	736317	
914785	944595	974423	004270	034135	
213717	243712	273726	303759	333810	
514506	544687	574886	605104	635341	
817151	847518	877903	908307	938729	
121653	152206	182776	213366	243974	
428012	458750	489507	520282	551075	
736228	767151	798093	829054	860034	
046300	077409	108537	139683	170849	

	0	1	2	3	4
167	25. 891032	922048	953083	984137	015209
168	26. 202032	233234	264455	295694	326952
169	26. 514689	546277	577684	609109	640552
170	26. 829604	861177	892769	924380	956009
171	27. 146174	177933	209711	241508	273322
172	27. 464602	496547	528510	560492	592493
173	27. 784886	817016	849166	881333	913520
174	28. 107027	139343	171678	204031	236403
175	28. 431025	463526	496047	528586	561142
176	28. 756879	789566	822273	854997	881740
177	29. 084590	117463	150355	183265	216194
178	29. 414158	447217	480294	513390	546505
179	29. 745582	778827	812090	845372	878672
180	30. 078864	112294	145743	179210	212696
181	30. 414001	447617	481252	514905	548577
182	30. 750996	784798	818618	852457	886314
183	31. 089848	123835	157841	192865	225908
184	31. 430556	464729	498920	533130	567359
185	31. 773121	807479	841856	876252	910666
186	32. 117542	152086	186649	221231	255831
187	32. 463820	498550	533299	568066	602852
188	32. 811955	846871	881805	916758	951729
189	33. 161947	197048	232168	267307	302464
190	33. 513796	549082	584388	619712	655055
191	33. 867501	902973	938464	973974	009503
192	34. 223063	258721	294398	330093	365807
193	34. 580481	616325	652188	688069	723968
194	34. 939756	975786	011834	047901	083986
195	35. 300889	337104	373338	409590	445861
196	35. 663877	700278	736698	773136	809593
197	36. 028723	065309	101915	138538	175181
198	36. 395425	432197	468988	505798	542626
199	36. 763984	800942	837918	874914	911927
200	37. 134400				

5	6	7	8	9	
046300	077409	108537	139683	170849	
358229	389524	420837	452169	483520	
672014	703495	734994	766512	798049	
987657	019323	051008	082712	114434	
305156	337008	368879	400768	432675	
624512	656549	688606	720681	752774	
945724	977948	010190	042450	074729	
268794	301213	333630	366076	398541	
593720	626314	658928	691559	724210	
920502	953283	986082	018899	051735	
249142	282108	315092	348096	381117	
579638	612790	645960	679149	712356	
919991	945328	978684	012059	045452	
246200	279723	313265	346825	380404	
582267	615975	649703	683449	717213	
920190	954084	987997	021929	055879	
252970	294050	328148	362265	396401	
601606	635872	670156	704459	738780	
945099	979551	014021	048509	083016	
290449	325508	359742	394416	429109	
637656	672479	707320	742180	777058	
986719	021728	056755	091800	126864	
337639	372833	408046	443277	478527	
690416	725796	761194	796611	832047	
045050	080615	116199	151802	187423	
401540	437291	473061	508849	544656	
759887	795824	831779	867753	903745	
120090	156213	192354	228514	264692	
482151	518459	554786	591131	627495	
846068	882562	919074	955605	992155	
211842	248521	285219	321936	358671	
579472	616337	653221	690124	727044	
948960	986010	023080	060168	097274	

	0	1	2	3	4
01	0. 002617	003167	003769	004424	005131
02	0. 010471	011545	012671	013849	015079
03	0. 023561	025158	026808	028509	030264
04	0. 041887	044008	046181	048406	050684
05	0. 065449	068093	070790	073539	076340
06	0. 094247	097415	100635	103908	107232
07	0. 128281	131973	135716	139512	143361
08	0. 167551	171766	176033	180353	184725
09	0. 212057	216796	221586	226430	231325
1.0	0. 261799	267061	272376	277742	283162
1.1	0. 316777	322563	328401	334291	340234
1.2	0. 376991	383300	389662	396076	402542
1.3	0. 442440	449273	456159	463096	470086
1.4	0. 513126	520483	527892	535353	542867
1.5	0. 589048	596928	604861	612846	620883
1.6	0. 670206	678610	687066	695574	704135
1.7	0. 756600	765527	774507	783539	792623
1.8	0. 848230	857680	867184	876739	886348
1.9	0. 945097	955070	965097	975176	985308
2.0	1. 047197	057695	068246	078849	089504
2.1	1. 154535	165557	176631	187757	198936
2.2	1. 267109	278654	290252	301902	313604
2.3	1. 384918	396987	409109	421282	433508
2.4	1. 507964	520557	533201	545899	558648
2.5	1. 636246	649362	662530	675751	689024
2.6	1. 769763	783403	797095	810840	824637
2.7	1. 908517	922680	036896	951164	965485
2.8	2. 052507	067194	081933	096725	111569
2.9	2. 201732	216943	232206	247521	262889
3.0	2. 356194				

5	6	7	8	9
005890	006702	007566	008482	009450
016362	017697	019085	020525	022017
032070	033929	035840	037803	039819
053014	055396	057831	060318	062858
079194	082100	085058	088069	091132
110610	114039	117521	121055	124642
147262	151215	155220	159278	163388
189149	193626	198155	202737	207371
236273	241274	246326	251432	256589
288633	294157	299734	305362	311043
346229	352277	358377	364529	370734
409061	415632	422256	482932	435660
477129	484224	491371	498570	505822
550433	558051	565722	573445	581220
628973	637114	645309	653555	661855
712748	721414	730132	738902	747725
801760	810949	820191	829485	838831
896008	905721	915486	925303	935173
995492	005728	016017	026358	036751
100211	110971	121784	132648	143565
210167	221451	232787	244175	255616
325359	337166	349026	360937	372902
445787	458117	470500	482936	495424
571450	584305	597211	610170	623182
702350	715728	729158	742641	756176
838486	852387	866341	880347	894406
979857	994283	008760	023290	037872
126465	141414	156415	171468	186574
278309	293781	309306	324883	340512

	0	1	2	3	4
10	0. 314159	345575	376991	408407	439822
20	0. 628318	659734	691150	722566	753982
30	0. 942477	974893	006309	037725	069148
40	1. 256637	288052	319468	350884	382300
50	1. 570796	602212	633628	665044	696460
60	1. 884955	916371	947787	979203	010619
70	2. 199114	230530	261946	293362	324778
80	2. 513274	544690	576105	607521	638937
90	2. 827433	858849	890265	921681	953097
1.00	3. 141592	173008	204424	235840	267256
10	3. 455751	487167	518583	549999	581415
20	3. 769911	801327	832743	864158	895574
30	4. 084070	115486	146902	178318	209734
40	4. 398229	429645	461061	492477	523893
50	4. 712388	743804	775220	806636	838052
60	5. 026548	057964	089380	120796	152211
70	5. 340707	372123	403539	434945	466371
80	5. 654866	686282	717698	749114	780530
90	5. 969026	000441	031857	063273	094689
2.00	6. 283105	314601	346017	377433	408849
10	6. 597344	628760	660176	691592	723008
20	6. 911503	942919	974336	005751	037167
30	7. 225663	257079	288494	319910	351326
40	7. 539822	571238	602654	634070	665486
50	7. 853981	885397	916813	948229	979645
60	8. 168140	199556	230972	262388	293804
70	8. 482300	513716	545132	576547	607963
80	8. 796458	827875	859291	890707	922123
90	9. 110618	142034	173450	204866	236282
3.00	9. 424777				

5	6	7	8	9	
471238	502654	534070	565486	596902	
785398	816814	848230	879645	911061	
100557	131973	162389	193805	225221	
413716	445132	476548	507964	539380	
727875	759291	790707	822123	853539	
042035	073451	104867	136283	167698	
356194	387610	419026	450442	481858	
670353	701769	733185	764601	796017	
984513	015928	047344	078760	110176	
298672	330088	361504	392920	424335	
613831	644247	675663	707079	738495	
926990	958406	989822	021238	052654	
241150	272566	303981	335397	366813	
555309	586725	618141	649557	680973	
869468	900884	932300	963716	995132	
183627	215043	246459	277875	309291	
497787	529203	560618	592034	623450	
811946	843362	874778	906194	937610	
126105	157521	188937	220353	251769	
440264	471680	503096	534512	565928	
754424	785840	817256	848671	880087	
068583	099999	131415	162831	194247	
382742	414158	445574	476990	508406	
696901	728317	759733	791149	822565	
011061	042477	073893	105309	136724	
325220	356636	388052	419468	450884	
639379	670795	702211	733627	765043	
953539	984954	016370	047786	079202	
267798	299114	330530	361946	393362	

	Natural	Artificial		Natural	Artificial
0.01	0.000002	4.423668	0.36	0.003437	7.536273
.02	0.000010	5.025728	0.37	0.003631	7.560071
.03	0.000023	5.377911	0.38	0.003830	7.583236
.04	0.000042	5.627788	0.39	0.004034	7.605798
0.05	0.000066	5.821608	0.40	0.004244	7.627788
.06	0.000092	5.979971	0.41	0.004458	7.649236
.07	0.000129	6.113864	0.42	0.004679	7.670167
.08	0.000169	6.229848	0.43	0.004904	7.690605
.09	0.000214	6.332153	0.44	0.005135	7 710574
0.10	0.000265	6.423668	0.45	0.005371	7.730093
.11	0.000320	6.506454	0.46	0.005612	7.749184
.12	0.000382	6.582031	0.47	0.005892	7.767864
.13	0.000448	6.651555	0.48	0.006111	7.786151
.14	0.000519	6.715924	0.49	0.006368	7.804060
0.15	0.000596	6.775851	0.50	0.006631	7.821608
.16	0.000679	6.831908	0.51	0.006899	7.838809
.17	0.000766	6.884566	0.52	0.007172	7.855675
.18	0.000859	6.934213	0.53	0.007451	7.872220
.19	0.000957	6.981176	0.54	0.007734	7.888456
0.20	0.001061	7.025728	0.55	0.008024	7.905394
.21	0.001169	7.068107	0.56	0.008318	7.720044
.22	0.001283	7.108514	0.57	0.008618	7.935418
.23	0.001403	7.147124	0.58	0.008923	7.950524
.24	0.001527	7.184091	0.59	0.009233	7.965372
0.25	0.001657	7.219548	0.60	0.009549	7.979971
.26	0.001793	7.253615	0.61	0.009870	7.994328
.27	0.001933	7.286396	0.62	0.010196	8.008452
.28	0.002012	7.317984	0.63	0.010528	8.022358
.29	0.002230	7.348464	0.64	0.010864	8.036028
0.30	0.002353	7.377911	0.65	0.011207	8.049495
.31	0.002549	7.406392	0.66	0.011554	8.062756
.32	0.002716	7.433968	0.67	0.011907	8.075818
.3	0.002888	7.460695	0.68	0.012265	8.088686
.3	0.003066	7.486626	0.69	0.012628	8.101367
0.35	0.003249	7.511804	0.70	0.012997	8.113864

	Natural	Artificial		Natural	Artificial
0.71	0.013371	8.126175	1.06	0.029804	8.474280
0.72	0.013750	8.138333	1.07	0.030365	8.482437
0.73	0.014135	8.150314	1.08	0.030939	8.490516
0.74	0.014525	8.162132	1.09	0.031515	8.498521
0.75	0.014920	8.173791	1.10	0.032096	8.506454
0.76	0.015321	8.185296	1.11	0.032682	8.514314
0.77	0.015727	8.190991	1.12	0.033273	8.522104
0.78	0.016138	8.207858	1.13	0.033870	8.528825
0.79	0.016554	8.218927	1.14	0.034472	8.537478
0.80	0.016976	8.229848	1.15	0.035080	8.545064
0.81	0.017403	8.240638	1.16	0.035697	8.552584
0.81	0.017835	8.251296	1.17	0.036324	8.560040
0.83	0.018273	7.261825	1.18	0.036934	8.567432
0.84	0.018716	8.272227	1.19	0.037563	8.574762
0.85	0.019164	8.282506	1.20	0.038197	8.582031
0.86	0.019618	8.292665	1.21	0.038836	8.589239
0.87	0.020077	8.302707	1.22	0.039481	8.596388
0.88	0.020541	8.312634	1.23	0.040130	8.603471
0.89	0.021011	8.322448	1.24	0.040786	8.610512
0.90	0.021489	8.332153	1.25	0.041446	8.617488
0.91	0.021999	8.341751	1.26	0.042112	8.624410
0.92	0.022451	8.351244	1.27	0.042783	8.631276
0.93	0.022942	8.360634	1.28	0.043459	8.638088
0.94	0.023438	8.369924	1.29	0.044141	8.644848
0.95	0.023939	8.379116	1.30	0.044828	8.651555
0.96	0.024446	8.388211	1.31	0.045520	8.658211
0.9	0.024958	8.397212	1.31	0.046218	8.664816
0.98	0.025475	8.406121	1.33	0.046921	8.671372
0.99	0.025997	8.414939	1.34	0.047629	8.677878
1.00	0.026529	8.423668	1.35	0.048343	8.684336
1.01	0.027058	8.432311	1.36	0.049062	8.689746
1.02	0.027597	8.442369	1.37	0.049786	8.697110
1.0	0.028141	8.449343	1.38	0.050515	8.703427
1.04	0.028690	8.456735	1.39	0.051250	8.709698
1.05	0.029[illegible]44	8.466047	1.40	0.051990	8.715924

	Natural	Artificial		Natural	Artificial
1.41	0.052735	8.722107	1.76	0.082166	8.914694
1.42	0.053453	8.728245	1.77	0.083102	8.919615
1.43	0.054242	8.734340	1.78	0.084044	8.924508
1.44	0.054007	8.740393	1.79	0.084991	8.929374
1.45	0.055770	8.746404	1.80	0.085943	8.934213
1.46	0.056542	8.752374	1.81	0.086901	8.939026
1.47	0.057319	8.758303	1.82	0.087864	8.943811
1.48	0.058102	8.764192	1.83	0.088832	8.948571
1.49	0.058889	8.770071	1.84	0.089805	8.953291
1.50	0.059687	8.775851	1.85	0.090784	8.958012
1.51	0.060481	8.781622	1.86	0.091768	8.962694
1.52	0.061285	8.793356	1.87	0.092758	8.967352
1.53	0.062094	8.793051	1.88	0.093752	8.971984
1.54	0.062908	8.798710	1.89	0.094418	8.976592
1.55	0.063728	8.804332	1.90	0.095748	8.981176
1.56	0.064556	8.809918	1.91	0.096768	8.985735
1.57	0.065383	8.815468	1.92	0.097784	8.990271
1.58	0.066219	8.820983	1.93	0.098806	8.994783
1.59	0.067059	8.826463	1.94	0.099832	8.999272
1.60	0.067906	8.831908	1.95	0.100864	9.003738
1.61	0.068754	8.837320	1.96	0.101901	9.008181
1.62	0.069614	8.842698	1.97	0.102944	9.012601
1.63	0.070476	8.848044	1.98	0.103981	9.016999
1.64	0.071343	8.853356	1.99	0.105044	9.021375
1.65	0.072216	8.858636	2.00	0.106103	9.025728
1.66	0.073091	8.863885	2.01	0.107166	9.030061
1.67	0.073944	8.869101	2.02	0.108235	9.034371
1.68	2.074533	8.874595	2.03	0.109310	9.038660
1.69	0.075760	8.879442	2.04	0.110389	9.042929
1.70	0.076659	8.884566	2.05	0.111441	9.047176
1.71	0.077564	8.889661	2.06	0.112564	9.051403
1.72	0.078440	8.894725	2.07	0.113660	9.055609
1.73	0.079355	8.899761	2.08	0.114427	9.059795
1.74	0.080309	8.904767	2.09	0.115867	9.063961
1.75	0.081235	8.909745	2.10	0.116978	9.068107

	Natural	Artificial
2.11	0.118095	9.072233
2.12	0.119210	9.076340
2.13	0.120345	9.080428
2.14	0.121477	9.084496
2.15	0.122614	9.088545
2.16	0.123758	9.092576
2.17	0.124907	9.096588
2.18	0.126061	9.100581
2.19	0.127220	9.104557
2.20	0.128384	9.108514
2.21	0.129554	9.112453
2.22	0.130729	9.116374
2.23	0.131910	9.120278
2.24	0.133095	9.124164
2.25	0.134286	9.128033
2.26	0.135483	9.131885
2.27	0.136684	9.135720
2.28	0.137891	9.139538
2.29	0.139104	9.143339
2.30	0.140321	9.147124
2.31	0.141544	9.150892
2.32	0.142772	9.154644
2.33	0.144006	9.158380
2.34	0.145244	9.162100
2.35	0.146488	9.165804
2.36	0.147738	9.169492
2.37	0.148992	9.173165
2.38	0.150252	9.176822
2.39	0.151518	9.180464
2.40	0.152788	9.184091
2.41	0.154064	9.187702
2.42	0.155345	9.191299
2.43	0.156632	9.194881
2.44	0.157924	9.198448
2.45	0.159221	9.202001
2.46	0.160523	9.205539
2.47	0.161831	9.209062
2.48	0.163144	9.212571
2.49	0.164462	9.216067
2.50	0.165786	9.219548
2.51	0.167115	9.222016
2.52	0.168449	9.226469
2.53	0.169789	9.229909
2.54	0.171133	9.233336
2.55	0.172484	9.236749
2.56	0.173839	9.240148
2.57	0.175200	9.243535
2.58	0.176566	9.246908
2.59	0.177937	9.250268
2.60	0.179314	9.253615
2.61	0.180685	9.256949
2.62	0.182083	9.260271
2.63	0.183476	9.263580
2.64	0.184874	9.266876
2.65	0.186277	9.270160
2.66	0.187686	9.273432
2.67	0.189099	9.276691
2.68	0.190519	9.279938
2.69	0.191943	9.283173
2.70	0.193373	9.286396
2.71	0.194808	9.289607
2.72	0.196248	9.292806
2.73	0.197694	9.295994
2.74	0.199145	9.299170
2.75	0.200601	9.302334
2.76	0.202630	9.305486
2.77	0.203529	9.308628
2.78	0.205002	9.311758
2.79	0.206479	9.314877
2.80	0.207962	9.317984

	Natural	Artificial
2.81	0.209450	9.321081
2.82	0.210943	9.324167
2.83	0.212442	9.327241
2.84	0.213946	9.330306
2.85	0.215455	9.333358
2.86	0.216970	9.336400
2.87	0.218490	9.339442
2.88	0.220015	9.342453
2.89	0.221546	9.344464
2.90	0.223082	9.348464
2.91	0.224623	9.351454
2.92	0.226169	9.354434
2.93	0.227721	9.357404
2.94	0.229278	9.360363
2.95	0.230840	9.363312
2.96	0.232408	9.366252
2.97	0.233981	9.369181
2.98	0.235559	9.372101
2.99	0.237143	9.375011
3.00	0.238732	9.377911
3.01	0.240326	9.380801
3.02	0.241926	9.383682
3.03	0.243530	9.386554
3.04	0.245141	9.389416
3.05	0.246756	9.392268
3.06	0.248377	9.395111
3.07	0.249003	9.397945
3.08	0.251634	9.400770
3.09	0.253271	9.403585
3.10	0.254713	9.406392
3.11	0.256627	9.409189
3.12	0.258212	9.411978
3.13	0.259870	9.414757
3.14	0.261534	9.417528
3.15	0.26320[illegible]	9.420290

	Natural	Artificial
3.16	0.264876	9.423043
3.17	0.266555	9.425787
3.18	0.268239	9.428523
3.19	0.269926	9.431250
3.20	0.271624	9.433968
3.21	0.273324	9.436678
3.22	0.275030	9.439380
3.23	0.276741	9.442073
3.24	0.278457	9.444758
3.25	0.280179	9.447435
3.26	0.281905	9.450104
3.27	0.283604	9.452764
3.28	0.285375	9.455416
3.29	0.287114	9.458060
3.30	0.288866	9.460695
3.31	0.290619	9.463324
3.32	0.292378	9.465945
3.33	0.294142	9.468557
3.34	0.295911	9.471161
3.35	0.297686	9.473758
3.36	0.299465	9.476347
3.37	0.301251	9.478928
3.38	0.303041	9.481502
3.39	0.304504	9.484068
3.40	0.306638	9.486626
3.41	0.308444	9.489177
3.42	0.310256	9.491721
3.43	0.312073	9.494257
3.44	0.313895	9.496785
3.45	0.315726	9.499307
3.46	0.317556	9.501821
3.47	0.319394	9.504327
3.48	0.321238	9.506782
3.49	0.323087	9.509319
3.50	0.324941	9.511804

	Natural	Artificial
3.51	0.326800	9.514283
3.52	0.328665	9.516754
3.53	0.330502	9.519218
3.54	0.332411	9.521675
3.55	0.334291	9.524125
3.56	0.336177	9.526568
3.57	0.338068	9.528005
3.58	0.339965	9.531434
3.59	0.341867	9.533857
3.60	0.343774	9.536273
3.61	0.345687	9.538683
3.62	0.347604	9.541086
3.63	0.349528	9.543482
3.64	0.351456	9.545871
3.65	0.353390	9.547254
3.66	0.355329	9.550631
3.67	0.357273	9.553001
3.68	0.359223	9.555364
3.69	0.361178	9.557721
3.70	0.363138	9.560071
3.71	0.365104	9.562416
3.72	0.367074	9.564754
3.73	0.369051	9.567086
3.74	0.371032	9.569412
3.75	0.373019	9.571731
3.76	0.375011	9.574044
3.77	0.377008	9.576351
3.78	0.379011	9.578652
3.79	0.381019	9.580947
3.80	0.383032	9.583236
3.81	0.385051	9.585518
3.82	0.387075	9.587795
3.83	0.389104	9.590066
3.84	0.391139	9.592331
3.85	0.393179	9.594590
3.86	0.395224	9.596743
3.87	0.397274	9.599090
3.88	0.399330	9.601332
3.89	0.401391	9.603568
3.90	0.403457	9.605798
3.91	0.405529	9.608022
3.92	0.407606	9.610241
3.93	0.409688	9.612454
3.94	0.411776	9.614661
3.95	0.413869	9.616863
3.96	0.415967	9.619059
3.97	0.418070	9.621249
3.98	0.420179	9.623435
3.99	0.422293	9.625614
4.00	0.424413	9.627788
4.01	0.426504	9.629957
4.02	0.428667	9.632121
4.03	0.430803	9.634279
4.04	0.432943	9.636431
4.05	0.435089	9.638578
4.06	0.437241	9.640720
4.07	0.439397	9.642857
4.08	0.441559	9.644989
4.09	0.443726	9.647115
4.10	0.445899	9.649236
4.11	0.448076	9.651352
4.12	0.450259	9.653463
4.13	0.452448	9.655569
4.14	0.454642	9.657669
4.15	0.456840	9.659765
4.16	0.459045	9.661855
4.17	0.461254	9.663941
4.18	0.463469	9.666021
4.19	0.465690	9.668096
4.20	0.467915	9.670167

	Natural	Artificial		Natural	Artificial
4.21	0.470146	9.672233	4.56	0.551567	9.741598
4.22	0.472382	9.674293	4.57	0.553989	9.743501
4.23	0.474623	9.676349	4.58	0.556416	9.745399
4.24	0.476870	9.678400	4.59	0.558848	9.747294
4.25	0.479122	9.680446	4.60	0.561286	9.749184
4.26	0.481380	9.682488	4.61	0.563729	9.751070
4.27	0.483642	9.684524	4.62	0.566177	9.752952
4.28	0.485910	9.686556	4.63	0.568631	9.754830
4.29	0.488183	9.688583	4.64	0.571090	9.756704
4.30	0.490462	9.690605	4.65	0.573554	9.758574
4.31	0.492746	9.692623	4.66	0.576024	9.760440
4.32	0.495032	9.694636	4.67	0.578499	9.762302
4.33	0.497330	9.696634	4.68	0.580979	9.764160
4.34	0.499629	9.698648	4.69	0.583464	9.766014
4.35	0.501934	9.700647	4.70	0.585955	9.767864
4.36	0.504245	9.702641	4.71	0.588451	9.769710
4.37	0.506560	9.704631	4.72	0.590952	9.771552
4.38	0.508882	9.706617	4.73	0.593459	9.773411
4.39	0.511208	9.708597	4.74	0.595971	9.775225
4.40	0.513539	9.710574	4.75	0.598488	9.777056
4.41	0.515876	9.712546	4.76	0.601011	9.778882
4.42	0.518219	9.714513	4.77	0.603539	9.780705
4.43	0.520566	9.716476	4.78	0.606072	9.782524
4.44	0.522919	9.718434	4.79	0.608611	9.784339
4.45	0.527277	9.720388	4.80	0.611154	9.786151
4.46	0.527641	9.722338	4.81	0.613704	9.787959
4.47	0.530009	9.724283	4.82	0.616258	9.789762
4.48	0.532383	9.726224	4.83	0.618818	9.791563
4.49	0.534429	9.728161	4.84	0.621383	9.793359
4.50	0.537147	9.730093	4.85	0.623953	9.795252
4.51	0.539537	9.732021	4.86	0.626529	9.796941
4.52	0.541933	9.733945	4.87	0.629110	9.798726
4.53	0.544333	9.735865	4.88	0.631696	9.800508
4.54	0.546739	9.737780	4.89	0.634288	9.802286
4.55	0.549150	9.739691	4.90	0.636885	9.804060

	Natural	Artificial		Natural	Artificial
4.92	0.639487	9.805831	5.26	0.733905	9.865640
4.92	0.642094	9.807599	5.27	0.736699	9.867290
4.93	0.644707	9.809362	5.28	0.739497	9.868936
4.94	0.647325	9.811122	5.29	0.742301	9.870580
4.95	0.649948	9.812879	5.30	0.745110	9.872220
4.96	0.652577	9.814632	5.31	0.747924	9.873857
4.97	0.655211	9.815638	5.32	0.750744	9.875492
4.98	0.657851	9.818127	5.33	0.753569	9.877223
4.99	0.660495	9.819869	5.34	0.756399	9.878751
5.00	0.663145	9.821608	5.35	0.759235	9.880376
5.01	0.665800	9.823344	5.36	0.762076	9.881998
5.02	0.668461	9.825076	5.37	0.764922	9.883617
5.03	0.671127	9.826804	5.38	0.767774	9.885233
5.04	0.673798	9.828529	5.39	0.770630	9.886846
5.05	0.676474	9.830451	5.40	0.77349[illegible]	9.888456
5.06	0.679156	9.831979	5.41	0.776360	9.890063
5.07	0.681843	9.833684	5.42	0.779233	9.891667
5.08	0.684536	9 835396	5.43	0.782111	9.892268
5.09	0.687267	9.837104	5.44	0.784994	9.894866
5.10	0.689936	9.838809	5.45	0.78788[illegible]	9.896461
5.11	0.692644	9.840516	5.46	0.790777	9.898054
5.12	0.695358	9.842208	5.47	0.793676	9.899643
5.13	0.698077	9.843903	5.48	0.796581	9.900230
5.14	0.700801	9.845595	5.49	0.799490	9.902813
5.15	0.703531	9 847283	5.50	0.802406	9.905394
5.16	0.706265	9.848968	5.51	0.805326	9.905972
5.17	0.709006	9.850649	5.52	0.808252	9.907547
5.18	0.711751	9.852328	5.53	0.811283	9 909119
5.19	0.71450	9.854003	5.54	0.814129	9.910688
5.20	0.717258	9.855675	5.55	0.817061	9.912254
5.21	0.720019	9.857344	5.56	0.820008	9.913818
5.22	0.722786	9.859009	5.57	0.822994	9.915379
5.23	0.725558	9.860672	5.58	0.825918	9 916937
5.24	.728335	9.862331	5.59	0.828881	9.918492
5:25	0.731118	9.863987	5.60	0.831849	9.920044

	Natural	Artificial
5.61	0.834823	9.921594
5.62	0.837802	9.923141
5.63	0.840786	9.924685
5.64	0.843775	9.926227
5.65	0.846770	9.927765
5.66	0.849770	9.929301
5.67	0.852776	9.930835
5.68	0.855786	9.932365
5.69	0.858802	9.933893
5.70	0.861824	9.935418
5.71	0.864850	9.936941
5.72	0.867882	9.938460
5.73	0.870919	9.939978
5.74	0.873963	9.941492
5.75	0.877010	9.943004
5.76	0.880069	9.944513
5.77	0.883121	9.946020
5.78	0.886185	9.947524
5.79	0.889254	9.949026
5.80	0.892328	9.950524
5.81	0.895408	9.952021
5.82	0.898493	9.953514
5.83	0.901586	9.955006
5.84	0.904679	9.956494
5.85	0.907779	9.957980
5.86	0.910886	9.959464
5.87	0.913997	9.960945
5.88	0.917114	9.962423
5.89	0.920236	9.963908
5.90	0.923363	9.965372
5.91	0.926496	9.966843
5.92	0.929967	9.968312
5.93	0.932777	9.969778
5.94	0.935926	9.971241
5.95	0.939080	9.972702
5.96	0.942239	9.974161
5.97	0.945404	9.975617
5.98	0.948574	9.977071
5.99	0.951749	9.978522
6.00	0.954929	9.979971
6.01	0.958115	9.981417
6.02	0.961306	9.982861
6.03	0.964502	9.984303
6.04	0.967704	9.985742
6.05	0.970911	9.987179
6.06	0.974123	9.988614
6.07	0.977341	9.990046
6.08	0.980564	9.991476
6.09	0.983792	9.992903
6.10	0.987025	9.994328
6.11	0.990264	9.995751
6.12	0.993508	9.997171
6.13	0.996758	9.998589
6.14	1.000012	0.000005
6.15	1.003272	0.001419
6.16	1.006538	0.002830
6.17	1.009808	0.004239
6.18	1.013084	0.005645
6.19	1.016366	0.007050
6.20	1.019652	0.008452
6.21	1.022944	0.009852
6.22	1.026241	0.011249
6.23	1.029544	0.012645
6.24	1.032851	0.014038
6.25	1.036164	0.015428
6.26	1.039450	0.016817
6.27	1.042807	0.018203
6.28	1.046136	0.019588
6.29	1.049470	0.020970
6.30	1.052809	0.022350

	Natural	Artificial
6.31	1.056154	0.023727
6.32	1.059505	0.025103
6.33	1.062860	0.026476
6.34	1.066331	0.027847
6.35	1.069587	0.029216
6.36	1.072958	0.030583
6.37	1.076335	0.031947
6.38	1.079717	0.033310
6.39	1.083105	0.034670
6.40	1.086497	0.036028
6.41	1.089899	0.037384
6.42	1.093298	0.038738
6.43	1.096707	0.040090
6.44	1.100121	0.041440
6.45	1.103540	0.042788
6.46	1.106965	0.044133
6.47	1.110394	0.045477
6.48	1.113829	0.046818
6.49	1.117270	0.048158
6.50	1.120716	0.049495
6.51	1.124167	0.050830
6.52	1.127623	0.052164
6.53	1.131084	0.053495
6.54	1.134551	0.054824
6.55	1.138024	0.056150
6.56	1.141501	0.057476
6.57	1.144984	0.058799
6.58	1.148472	0.060120
6.59	1.152966	0.061439
6.60	1.155464	0.062758
6.61	1.158968	0.064071
6.62	1.162478	0.065438
6.63	1.165992	0.066895
6.64	1.166951	0.068005
6.65	1.173038	0.069312
6.66	1.175688	0.070617
6.67	1.180104	0.071920
6.68	1.183645	0.073221
6.69	1.187192	0.074521
6.70	1.190744	0.075815
6.71	1.194301	0.077113
6.72	1.197863	0.078407
6.73	1.201431	0.079699
6.74	1.205004	0.080988
6.75	1.208582	0.082276
6.76	1.212166	0.083562
6.77	1.215755	0.084846
6.78	1.219349	0.086118
6.79	1.222949	0.087408
6.80	1.226554	0.088686
6.81	1.230164	0.089963
6.82	1.233779	0.091237
6.83	1.237073	0.092510
6.84	1.241026	0.093781
6.85	1.244657	0.095049
6.86	1.248294	0.096317
6.87	1.252936	0.097582
6.88	1.255587	0.098845
6.89	1.259236	0.100107
6.90	1.262894	0.101367
6.91	1.266557	0.102525
6.92	1.270226	0.103881
6.93	1.274900	0.105135
6.94	1.27757	0.106387
6.95	1.28126	0.107638
6.96	1.28495	0.108877
6.97	1.288648	0.110134
6.98	1.292348	0.111379
6.99	1.296054	0.112623
7.00	1.299765	0.113864

	Natural	Artificial
7.01	1.303481	0.115104
7.02	1.307203	0.116343
7.03	1.310930	0.117579
7.04	1.314662	0.118814
7.05	1.318399	0.120047
7.06	1.322142	0.121278
7.07	1.325890	0.122507
7.08	1.329644	0.123735
7.09	1.333402	0.124961
7.10	1.337166	0.126175
7.11	1.340936	0.127408
7.12	1.344710	0.128628
7.13	1.348490	0.129747
7.14	1.352275	0.131065
7.15	1.356066	0.132280
7.16	1.359862	0.133494
7.17	1.363667	0.134707
7.18	1.367469	0.135917
7.19	1.371281	0.137126
7.20	1.375098	0.138333
7.21	1.378921	0.139539
7.22	1.382748	0.140743
7.23	1.386581	0.141946
7.24	1.390419	0.143146
7.25	1.394263	0.144344
7.26	1.398112	0.145542
7.27	1.401966	0.146737
7.28	1.405826	0.147931
7.29	1.409691	0.149123
7.30	1.413561	0.150314
7.31	1.417436	0.151503
7.32	1.421317	0.152691
7.33	1.425203	0.153876
7.34	1.429094	0.155060
7.35	.432991	0.156243
7.36	1.436893	0.157424
7.37	1.440800	0.158603
7.38	1.444713	0.159781
7.39	1.448630	0.160957
7.40	1.452554	0.162132
7.41	1.456482	0.163305
7.42	1.460416	0.164476
7.43	1.464355	0.165646
7.44	1.468299	0.166814
7.45	1.472249	0.167981
7.46	1.476204	0.169146
7.47	1.480164	0.170310
7.48	1.484130	0.171472
7.49	1.488101	0.172632
7.50	1.492077	0.173791
7.51	1.496059	0.174948
7.52	1.500045	0.176104
7.53	1.504038	0.177218
7.54	1.508035	0.178411
7.55	1.512038	0.179552
7.56	1.516046	0.180712
7.57	1.520059	0.181860
7.58	1.524078	0.183007
7.59	1.528102	0.184152
7.60	1.532131	0.185296
7.6	1.536166	0.186438
7.62	1.540260	0.187578
7.63	1.544251	0.188717
7.64	1.548301	0.189855
7.65	1.552355	0.190991
7.66	1.556418	0.192126
7.67	1.560418	0.193259
7.68	1.564556	0.194391
7.69	1.568633	0.195521
7.70	1.572716	0.196650

	Natural	Artificial
7.71	1.576803	0.197777
7.72	1.580896	0.198903
7.73	1.584994	0.200027
7.74	1.589098	0.201150
7.75	1.593207	0.202272
7.78	1.597321	0.203402
7.77	1.601440	0.204500
7.78	1.605565	0.205628
7.79	1.609695	0.206744
7.80	1.613831	0.207858
7.81	1.617971	0.208970
7.82	1.622117	0.210082
7.83	1.626269	0.211192
7.84	1.630425	0.212311
7.85	1.634587	0.213408
7.86	1.638754	0.214514
7.87	1.642927	0.215618
7.88	1.647105	0.216721
7.89	1.651288	0.217822
7.90	1.655476	0.218923
7.91	1.659670	0.220021
7.92	1.663869	0.221119
7.93	1.668073	0.222215
7.94	1.672283	0.223309
7.95	1.676498	0.224403
7.96	1.680718	0.225495
7.97	1.684944	0.226585
7.98	1.689175	0.227674
7.99	1.693411	0.228762
8.00	1.697652	0.229848
8.01	1.701899	0.230933
8.02	1.706151	0.232017
8.03	.710408	0.233100
8.04	1.714671	0 234181
8.05	1.718939	0.235260

	Natural	Artificial
8.06	1.723212	0.236338
8.07	1.727491	0.237415
8.08	1.731775	0.238491
8.09	1.736064	0.239565
8.10	1.740359	0.240638
8.11	1.744659	0.241710
8.12	1.748964	0.242780
8.13	1.753274	0.243850
8.14	1.757590	0.244917
8.15	1.761911	0.245984
8.16	1.766237	0.247049
8.17	1.770569	0.248113
8.18	1.774906	0.249175
8.19	1.779248	0.250236
8.20	1.783596	0.251296
8.21	1.787949	0.252355
8.22	1.792307	0.253412
8.23	1.796670	0.254468
8.24	1.801039	0.255523
8.25	1.805413	0.256576
8.26	1.809793	0.257629
8.27	1.814177	0.258679
8.28	1.818568	0.259729
8.29	1.822963	0.260777
8.30	1.827363	0.261825
8.31	1.831769	0.262870
8.32	.836181	0.263915
8.3	1.840597	0.264958
8.34	1.845019	0.266001
8.3	1.849480	0.267041
8.36	1.853879	0.268081
8.37	1.858316	0.269119
8.38	1.86 760	0.270156
8.39	.867208	0.271192
8.40	1.871662	0.272227

	Natural	Artificial		Natural	Artificial
8.41	1.876121	0.273250	8.76	2.035528	0.308677
8.42	1.880585	0.274293	8.77	2.040177	0.309668
8.43	1.885054	0.275324	8.78	2.044833	0.310657
8.44	1.889529	0.276353	8.79	2.049493	0.311646
8.45	1.894010	0.277382	8.80	2.054159	0.312634
8.46	1.898495	0.278409	8.81	2.058830	0.313620
8.47	1.902886	0.279435	8.82	2.063507	0.314606
8.48	1.907482	0.280450	8.83	2.068189	0.315590
8.49	1.911983	0.281484	8.84	2.072876	0.316573
8.50	1.916490	0.282506	8.85	2.077568	5.317555
8.51	1.921002	0.283528	8.86	2.082266	0.318536
8.52	1.925520	0.283748	8.87	2.086969	0.319516
8.53	1.930042	0.285566	8.88	2.091677	0.320494
8.54	1.934570	0.286584	8.89	2.096391	0.321472
8.55	1.939104	0.287601	8.90	2.101110	0.322448
8.56	1.943642	0.288616	8.91	2.105834	0.323424
8.57	1.948186	0.289630	8.92	2.110564	0.324498
8.58	1.952735	0 290643	8.93	2.115299	0.325371
8.59	1.957290	0.291655	8.94	2.120039	0.326343
8.60	1.961849	0.292665	8.95	2.124784	0.327314
8.61	1.966414	0.293675	8.96	2.129535	0.328284
8.62	1.970985	0.294683	8.97	2.134291	0.329253
8.63	1.975561	0.295690	8.98	2.139053	0.330221
8.64	1.980142	0.296696	8.99	2.143819	0.331178
8.65	1.984728	0.297701	9.00	2.148591	0.332153
8.66	1.989320	0.298704	9.01	2.153368	2.333118
8.67	1.993916	0.299707	9.02	2.158151	0.334081
8.68	1.998529	0.300708	9.03	2.162939	0.335044
8.69	2.003126	0.301708	9.04	2.167732	0.336005
8.70	2.007406	0.302707	9.05	2.172531	0.337966
8.71	2.012357	0.303705	9.06	2.177335	0.338925
8.72	2.016981	0.304701	9.07	2.182144	0.338883
8.73	2.021609	0.305697	9.08	2.186958	0.339840
8.74	2.026243	0.306691	9.09	2.191778	0.340796
8.75	2.030883	0 307685	9.10	2.196603	0.341751

	Natural	Artificial
9.11	2.201433	0.342705
9.12	2.206269	0.343658
9.13	2.211110	0.344610
9.14	2.215956	0.345561
9.15	2.220808	0.346511
9.16	2.225665	0.347459
9.17	2.230527	9.348407
9.18	2.235394	0.349354
9.19	2.240267	0.350299
9.20	2.245145	0.351244
9.21	2.250029	0.352881
9.22	2.254917	0.353130
9.23	2.259811	0.354072
9.24	2.264711	0.355012
9.25	2.269615	0.355872
9.26	2.274525	0.356890
9.27	2.279440	0.357828
9.28	2.284361	0.358764
9.29	2.289287	0.359700
9.30	2.294218	0.360634
9.31	2.299154	0.361568
9.32	2.304056	0.362500
9.33	2.309043	0.363432
9.34	2.313996	0.364362
9.35	2.318953	0.365292
9.36	2.323916	0.366220
9.37	2.328885	0.367148
9,38	2.333858	0.368074
9.39	2.338847	0.369000
9.40	2 343821	0.369924
9.41	2.348144	0.370848
9.42	2.353806	0.371770
9.43	2.358806	0.372692
9.44	2.363478	0.373612
9.45	2.368489	0.374532

	Natural	Artificial
9.46	2.373838	0.375451
9.48	2.378893	0.376368
9.48	2.383886	0.377285
9.49	2.388918	0.378201
9.50	2.393955	0.379116
9.51	2.398998	0.380029
9.52	2.404045	0.380942
9.53	2.409099	0.381854
9.54	2.414157	0.382765
9.55	2.419221	0.383675
9.56	2.424290	0.384584
9.57	2.429364	0.385492
9.58	2.434444	0.386399
9.59	2.439529	0.387306
9.60	2.444629	0.388211
9.61	2.449715	0.389115
9.62	2.454816	0.390019
9.63	2.459922	0.390921
9.64	2.465034	0.391822
9.65	2.470150	0.392723
9.66	2.475273	0.393623
9.67	2.480400	0.394521
9.68	2.485533	0.395419
9.69	2.490671	0.396316
9.70	2.495814	0.397212
9.71	2.500963	0.398107
9.72	2.506117	0.399001
9.73	2.511243	0.399894
9.74	2.516441	0.400786
9.75	2.521611	0.401678
9.76	2.526786	0.402568
9.77	2.531966	0.403458
9.78	2.537152	0.404346
9.79	2.542343	0.405234
9.80	2.547540	0.406121

	Natural	Artificial
9.81	2.552745	0.407006
9.82	2.557948	0.407891
9.83	2.563164	0.408775
9.84	2.568378	0.409659
9.85	2.573601	0.410541
9.86	2.578829	0.411422
9.87	2.584063	0.412303
9.88	2.589302	0.413182
9.89	2.594546	0.414061
9.90	2.599795	0.414939
9.91	2.605050	0.415816
9.92	2.610310	0.416692
9.93	2.615573	0.417567
9.94	2.620846	0.418441
9.95	2.626122	0.419315
9.96	2.631404	0.420187
9.97	2.636690	0.421059
9.98	2.641982	0.421929
9.99	2.647279	0.422789
10.00	2.652582	0.423668

A Table

A Table for the ſpeedy finding of the Length or Circumference anſwering to any Arch in Degrees and Decimal Parts.

A Table for the speedy finding of the Length or Circumference answering to any Arch, in Degrees and Decimal Parts.

7854

1	0.0174	5329	2519
2	0.0349	0658	5038
3	0.0523	5987	7557
4	0.0698	1317	0076
5	0.0872	6646	2595
6	0.1047	1975	5114
7	0.1221	7304	7633
8	0.1396	2634	0152
9	0.1570	7963	2671
10	0.1745	3292	5190
11	0.1919	8621	7709
12	0.2094	3951	0228
13	0.2268	9280	2747
14	0.2443	4609	5266
15	0.2617	9938	7785
16	0.2792	5268	0304
17	0.2967	0597	2823
18	0.3141	5926	5342
19	0.3316	1255	7861
20	0.3490	6585	0380
21	0.3665	1914	2899
22	0.3839	7245	5418
23	0.4014	2572	7937
24	0.4188	7902	0456
25	0.4363	3231	2975
26	0.4537	8560	5495
27	0.4712	3889	8013
28	0.4886	8219	0532
29	0.5061	4548	3051
30	0.5235	4877	5570
31	0.5410	5206	8089
32	0.5585	0536	0608
33	0.5759	5865	3127
34	0.5934	1194	5646
35	0.6108	6523	8165
36	0.6283	1853	0684
37	0.6457	7128	3203
38	0.6632	2511	5722
39	0.6806	7840	8241
40	0.6981	3170	0760
41	0.7155	8499	3279
42	0.7330	3828	5798
43	0.7504	9157	8317
44	0.7679	4487	0836
45	0.7853	9816	3355
46	0.8028	3145	5874
47	0.8203	0474	8393
48	0.8377	5804	0912
49	0.8552	1133	3431
50	0.8726	6462	4950

A Table for the speedy finding of the Length or Circumference answering to any Arch, in Degrees and Decimal Parts.

51	0. 8901	1791	8469	76	1. 3264	5023	1444
52	0. 9075	7121	0988	77	1. 3439	0352	3963
53	0. 9250	2450	3507	78	1. 3613	5681	6482
54	0. 9424	7779	6026	79	1. 3788	1010	9001
55	0. 9599	3108	8545	80	1. 3962	6340	1520
56	0. 9773	8438	1064	81	1. 4137	1669	4039
57	0. 9948	3767	3583	82	1. 4311	6998	6558
58	1. 0122	9096	6102	83	1. 4486	2327	9057
59	1. 0297	4425	8621	84	1. 4660	7657	1596
60	1. 0471	9755	1140	85	1. 4835	2986	4115
61	1. 0646	5084	3659	86	1. 5009	8315	6634
62	1. 0821	0413	6178	87	2. 5184	3644	9153
63	1. 0995	5742	8697	88	1. 5358	8974	1572
64	1. 1170	1072	1216	89	1. 5533	4303	4191
65	1. 1344	6401	3735	90	1. 5707	9632	6710
66	1. 1519	1730	6254	91	1. 5882	4961	9229
67	1. 1693	7059	8773	92	1. 6057	0291	1748
68	1. 1868	2389	1292	93	1. 6231	5620	4267
69	. 2042	7718	3811	94	1. 6406	0949	6786
70	1. 2217	3047	6330	95	1. 6580	6278	9305
71	1. 2391	8376	8849	96	1. 6755	1608	1824
72	1. 2566	3706	1368	97	1. 6929	6937	4343
73	1. 2740	9035	3887	98	1. 7104	2266	6862
74	1. 2915	4364	6406	99	1. 7278	7595	9381
75	1. 3089	9693	8925	100	1. 7453	2925	1900

A Common Divisor for the speedy converting of the Table, shewing the *Area* of the Segments of a Circle whose Diameter is 2.0000 &c. into a Table shewing the *Area* of the Segment of any Circle whose *Area* is given.

1	0031	4159	2653	26	0816	8140	8978
2	0062	8318	5306	27	0848	2300	1631
3	0094	2477	7959	28	0889	6459	4284
4	0125	6637	0612	29	0911	0618	6937
5	0157	0796	3265	30	0942	4777	9590
6	0188	4955	5918	21	0973	8937	2243
7	0219	9114	8571	32	1005	3096	4896
8	0251	3274	1224	33	1036	7255	7549
9	0282	7433	3877	34	1068	1415	0202
10	0314	1592	6530	35	1099	5574	2855
11	0345	5751	9183	36	1130	9733	5508
12	0376	9911	1836	37	1162	3892	8161
13	0408	4070	4489	38	1193	8052	0814
14	0439	8229	7142	39	1225	2211	3467
15	0471	2388	9795	40	1256	6370	6120
16	0502	6548	2448	41	1288	0529	8773
17	0534	0707	5101	42	1319	4689	1426
18	0565	4866	7754	43	1350	8848	4079
19	0596	9026	0407	44	1382	3007	6732
20	0628	3185	3060	45	1413	7166	9385
21	0659	7344	5713	46	1445	1326	2038
22	0691	1503	8366	47	1476	5485	4691
23	0722	5663	1019	48	1507	9644	7344
24	0753	9822	3672	49	1539	3803	9997
25	0785	3981	6325	50	1570	7963	2659

A Common Divisor for the speedy converting of the Table, shewing the *Area* of the Segments of a Circle whose Diameter is 2. 0000 &c. into a Table shewing the *Area* of the Segment of any other Circle whose *Area* is given.

51	1602	2122	5303
52	1633	6281	7956
53	1665	0441	0609
54	1696	4600	3262
55	1727	8759	5915
56	1759	2918	6568
57	1790	7078	1221
58	1822	1237	3874
59	1853	5396	6527
60	1884	9555	9180
61	1916	3715	1833
62	1947	7874	4486
63	1979	2033	7139
64	2010	6192	9792
65	2042	0352	2445
66	2073	4511	5098
67	2104	8670	7751
68	2136	2830	0404
69	2167	6989	3057
70	2199	1148	5710
71	2230	5307	8363
72	2261	9467	1016
53	2293	3626	3669
74	2324	7785	6322
75	2356	1944	8975
76	2387	6104	1628
77	2419	0263	4281
78	2450	4422	6934
79	2481	8581	9587
80	2513	2741	2240
81	2544	6900	4893
82	2576	1059	7546
83	2607	5219	0199
84	2638	9378	2852
85	2670	3537	5505
86	2701	7696	8158
87	2733	1856	0811
88	2764	6015	3464
89	2796	0174	6117
90	2827	4333	8770
91	2858	8493	1423
92	2890	2652	4076
93	2921	6811	6729
94	2953	0970	9382
95	2984	5130	2035
96	3015	9289	4688
97	3047	3448	7341
98	3078	7607	9994
99	3110	1767	2647
100	3141	5926	5300

A Table ſhewing the Ordinates, Arches and Areas of the Segments of a Circle, whoſe Diameter is 2000, *&c.* to every Hundredth Part of the *Radius*.

Ordinates

	Ordinates	Deg.& Dec.p.	Areas 2) 3.14159964
1000	10000000000	90.00000000	1.57079632
990	9999499971	89.42704196	1.55079682
980	9997999799	88.85400799	1.53079890
970	9995498987	88.28987110	1.51080538
960	99919967974	87.70756124	1.49081774
950	9987492177	87.13402020	1.47083808
940	9981983770	86.56018749	1.45086837
930	9975469913	85.98601581	1.43091081
920	9967948635	85.41143529	1.41096718
910	9959417653	84.83639513	1.39103966
900	9949874371	84.26083018	1.37113017
890	9939315871	83.68468641	1.35124084
880	9927738916	83.10789860	1.35137360
870	9915139938	82.53040793	1.31153053
860	9901515035	81.95215479	1.29171372
850	9886859966	81.37307468	1.27192518
840	9871170138	80.79310474	1.25216697
830	9854440623	80.21218180	1.23244118
820	9836666101	79.63024030	1.21274989
810	9817840903	79.04721672	1.19309522
80	9797958971	78.46304188	1.17347924
79	9777013859	77.87762112	1.15390361
78	9754998718	77.29096735	1.13437189
77	9731906288	76.70292903	1.11488481
76	9707728879	76.11343681	1.09544458
75	9682458365	75.52248845	1.07605462
74	9656086163	74.92996014	1.05671627
73	9628603221	74.33573392	1.03743102
72	9600000000	73.73979456	1.01820220
71	9570266454	73.14202474	0.99903143
70	9539392014	72.54239737	0.97992192
69	950[illegible]365565	71.94076969	0.96087497
68	9474175425	71.33707564	0.94189323
67	9439809319	70.73122476	0.92297905

	Ordinates	Deg. & Dec. p.	Areas
67	9439809319	70.73122476	0.92297905
66	9404254356	70.12312662	0.90413479
65	9367496997	69.51268522	0.88536283
64	9329523031	68.89980401	0.86666560
63	9290317540	68.28438326	0.84804557
62	9249864864	67.66631784	0.82950517
61	9208148564	67.04550117	0.81104695
60	9165151389	66.42182324	0.79267345
59	9120855222	65.79516567	0.77438721
58	9075241043	65.16541298	0.75619089
57	9028288874	64.53244020	0.73808713
56	8979977728	63.89612058	0.72007866
55	8930285549	63.25631645	0.70216884
54	8879189152	62.61289754	0.68435845
53	8826664149	61.96570387	0.66665234
52	8772684879	61.31459838	0.64905275
51	8717224755	60.65941181	0.63156249
50	8660254037	60.00000000	0.61418485
49	8601744009	59.33617061	0.59692260
48	8541662601	58.66774875	0.57977892
47	8479976415	57.99454553	0.56275702
46	8416650165	57.31636147	0.54586011
45	8351646544	56.63307065	0.52909299
44	8284926070	55.94420256	0.51245467
43	8216446926	55.24977433	0.49595300
42	8146264741	54.54945742	0.47959008
41	8074032449	53.84299205	0.46336957
40	8000000000	53.13010237	0.44725221
39	7924014134	52.41049708	0.43137885
38	7846018098	51.68386597	0.41560051
37	7765951325	50.94987748	0.39998818
36	7683749084	50.20810657	0.38453683
35	7599342076	49.45831012	0.36925312
34	7512655988	48.70012721	0.35414227

	Ordinates	Deg.& Dec.p.	Areas	
34	7512655988	48.70012721	0.35414227	
33	7423610981	47.93293539	0.33920561	
32	7332121111	47.15635717	0.32444946	
31	7238093671	46.36989113	0.30987884	
30	7141428428	45.57299618	0.29549884	
29	7042016756	44.76508489	0.28131493	
28	6939740629	43.94551977	0.26733268	
27	6834471449	43.11360613	0.25355796	
26	6726068688	42.26858452	0.23999689	
25	6614378277	41.40962595	0.22665594	
24	6499230723	40.53580228	0.21354168	
23	6380438856	39.64611132	0.20066138	
22	6257795138	38.73942400	0.18802248	
21	6131068422	37.81448867	0.17563291	
20	6000000000	36.86989765	0.16350111	
19	5864298764	35.90406873	0.15163601	
18	5723635208	34.91520640	0.14004722	
17	5577633906	33.90125515	0.12874491	
16	5425863986	32.85988059	0.11774053	
15	5267826876	31.78833069	0.10704574	
14	5102940328	30.68341722	0.09667379	
13	4930517214	29.54136121	0.08663902	
12	4749736834	28.35773666	0.07695728	
11	4559605246	27.12675321	0.06764629	
10	4358898943	25.84193282	0.05872590	
09	4146082488	24.49464857	0.05021866	
08	3919183588	23.07391815	0.04215095	
07	3675595189	21.56518547	0.03455313	
06	3411744421	19.94844363	0.02746204	
05	3122498999	18.19487244	0.02092302	
04	2800000000	16.26020471	0.01499411	
03	2431049156	14.06986184	0.00975364	
02	1989974874	11.47834097	0.00551730	
01	1410673597	8.10961446	0.00188278	

James Burgess - Ridd

	Ordinates	Deg. & Dec. p.	Areas
010	1410673597	8.10961446	0.00188278
009	1338618691	7.69281247	0.00160779
008	1262378707	7.25224680	0.00134761
007	1181143513	6.78328892	0.00110317
006	1093800713	6.27958064	0.00087554
005	0998749217	5.73196797	0.00066616
004	0893532316	5.12640010	0.00047674
003	0774015503	4.43922228	0.00030969
002	0632139225	3.62430750	0.00016860
001	0447101778	2.56255874	0.00005961

The

	2.00000
1000	1. 57079632
999	1·99999
	1. 56879632
998	1·99999
	1. 56679632
	1·99999
997	1. 56479633
	1·99998
996	1. 56279634
	1·99997
995	1. 56079636
	1·99996
994	1. 55879639
	1·99995
993	1. 55679644
	1·99994
992	1. 55479649
	1·99992
991	1. 55299657
	199991
990	1. 55079666
	199988
989	1. 54879677
	199986
988	1. 54679690
	199984
987	1. 54479706
	199981
986	1. 54279724
	199978
985	1. 54079745
	199976
984	1. 53879769
	199972
983	1. 53679796

983	1. 53679796
	199969
982	1. 53479827
	199965
981	1. 53279862
	199962
980	1. 53079899
	199957
979	1. 52879941
	199953
978	1. 52679988
	199949
977	1. 52480039
	199944
976	1. 52280095
	199939
975	1. 52080156
	199934
974	1. 51880222
	199929
973	1. 51680293
	199924
972	1. 51480369
	199918
971	1. 51280451
	199912
970	1. 51080539
	199906
969	1. 50880633
	199909
968	1. 50680733
	199894
967	1. 50480839
	199887
966	1. 50280952

M

966	1.50280952	949	1.46884063
	199880		199734
965	1.50081072	948	1.46684328
	199873		199724
964	1.49881199	947	1.46484604
	199866		199713
963	1.49681333	946	1.46284890
	199859		199702
962	1.49481474	945	1.46085187
	199851		199691
961	1.49281623	944	1.45885496
	199843		199680
960	1.49081774	943	1.45685815
	199835		199669
959	1.48881938	942	1.45486146
	199827		199657
958	1.48682110	941	1.45286489
	199819		199645
957	1.48482291	940	1.45086837
	199810		199633
956	1.48282480	939	1.44887204
	199801		199621
955	1.48082678	938	1.44687583
	199792		199608
954	1.47882885	937	1.44487975
	199783		199596
953	1.47683102	936	1.44288379
	199774		199585
952	1.47483328	935	1.44088794
	199764		199570
951	1.47283563	934	1.43889224
	199754		199557
950	1.47083808	933	1.43689667
	199744		199543
949	1.46884063	932	1.43490124

932	1.43490124	915	1.40100159
	199530		199267
931	1.43290594	914	1.39900892
	199516		199250
930	1.43091078	913	1.39701642
	199502		199232
929	1.42891578	912	1.39502410
	199488		199215
928	1.42692090	911	1.39303195
	199473		199197
927	1.42492617	910	1.39103998
	199459		199178
926	1.42293158	909	1.38904820
	199444		199160
925	1.42093714	908	1.38705660
	199429		199142
924	1.41894305	907	1.38506518
	199413		199123
923	1.41694892	906	1.38307395
	199398		199104
922	1.41495494	905	1.38108291
	199382		199085
921	1.41296112	904	1.37909206
	199366		199066
920	1.41096746	903	1.37710140
	199350		199047
919	1.40897396	902	1.37511093
	199334		199027
918	1.40698062	901	1.37312066
	199318		199007
917	1.40498744	900	1.37113059
	199301		
916	1.40299443		
	199284		
915	1.40100159		

900	1.37113017	
	198987	
899	1.36914030	
	198967	
898	1.36715063	
	198946	
897	1.36516117	
	198925	
896	1.36317192	
	198904	
895	1.36118288	
	198883	
894	1.35919405	
	198861	
893	1.35720544	
	198839	
892	1.35521705	
	198818	
891	1.35322887	
	198797	
890	1.35124090	
	198775	
889	1.34925315	
	198752	
888	1.34726563	
	198729	
887	1.34527834	
	198707	
886	1.34329127	
	198684	
885	1.34130443	
	198661	
884	1.33931782	
	198638	
883	1.33733144	

883	1.33733144	
	198619	
882	1.33534525	
	198590	
881	1.33335935	
	198566	
880	1.33137360	
	198541	
879	1.32938819	
	198517	
878	1.32740302	
	198499	
877	1.32541803	
	198480	
876	1.32343323	
	198449	
875	1.32144874	
	198418	
874	1.31946456	
	198393	
873	1.31748063	
	198367	
872	1.31549696	
	198341	
871	1.31351355	
	198315	
870	1.31153053	
	198289	
869	1.30954764	
	198262	
868	1.30756502	
	198235	
867	1.30558267	
	198209	

	198209
866	1.30360058
	198182
865	1.30161876
	198154
864	1.29963722
	198127
863	1.29765595
	198100
862	1.29567495
	198072
861	1.29369423
	198044
860	1.29171379
	198015
859	1.28973357
	197986
858	1.28775371
	197958
857	1.28577413
	197929
856	1.28379484
	197900
855	1.28181584
	197871
854	1.27983713
	197841
853	1.27785872
	197811
852	1.27588061
	197781
851	1.27390280
	197751
850	1.27192529

850	1.27192518
	197721
849	1.26994797
	197691
848	1.26797106
	197660
847	1.26599446
	197629
846	1.26401817
	197598
845	1.26204219
	197561
844	1.26006658
	197534
843	1.25809124
	197489
842	1.25611635
	197457
841	1.25414178
	197427
840	1.25216751
	197395
839	1.25019356
	197374
838	1.24821982
	197341
837	1.24624641
	197308
836	1.24427333
	197275
835	1.24230058
	197241
834	1.24032817
	197212

	197272
833	1.23835605
	197173
832	1.23638432
	197139
831	1.23441293
	197105
830	1.23244118
	197072
829	1.23047046
	197036
828	1.22850010
	197001
827	1.22653009
	196966
826	1.22456043
	196930
825	1.22259113
	196895
824	1.22062218
	196861
823	1.21865357
	196825
822	1.21668532
	196787
821	1.21471745
	196750
820	1.21274989
	196714
819	1.21078275
	196677
818	1.20881598
	196640
817	1.20684958

817	1.20684954
	196603
816	1.20488355
	196565
815	1.20291790
	196527
814	1.20095263
	196479
813	1.19898774
	196451
812	1.19702323
	196413
811	1.19505910
	196375
810	1.19309525
	196347
809	1.19113254
	196298
808	1.18916956
	196258
807	1.18720698
	196219
806	1.18524479
	196188
805	1.18328291
	196148
804	1.18132143
	196100
803	1.17936043
	196060
802	1.17739983
	196019
801	1.17543964
	195978
800	1.17347986

800	1. 17347924		784	1. 14217966	
	195938			195256	
799	1. 17151986		783	1. 14022710	
	195897			195211	
798	1. 16956089		782	1. 13827499	
	195855			195166	
797	1. 16760234		781	1. 13632333	
	195814			195122	
796	1. 16564420		780	1. 13437211	
	195773			195076	
795	1. 16368647		779	1. 13242135	
	195731			195031	
794	1. 16172916		778	1. 13047102	
	195689			194985	
793	1. 15977227		777	1. 12852117	
	195646			194939	
792	1. 15781581		776	1. 12657178	
	195603			194893	
791	1. 15585978		775	1. 12462285	
	195561			194847	
790	1. 15390417		774	1. 12267438	
	195518			194801	
789	1. 15194899		773	1. 12072637	
	195472			194755	
788	1. 14999427		772	1. 11877882	
	195429			194708	
787	1. 14803998		771	1. 11683174	
	195388			194661	
786	1. 14608610		770	1. 11488487	
				194614	
	195344		769	1. 11293867	
785	1. 14413266			194566	
	195300		768	1. 11099301	
784	1. 14217966			194518	

	194518
767	1.10904783
	194471
766	1.10710312
	194423
765	1.10515889
	194374
764	1.10321515
	194325
763	1.10127190
	194276
762	1.09932914
	194227
761	1.09738687
	194173
760	1.09544514
	194129
759	1.09350385
	194079
758	1.09156306
	194029
757	1.08962277
	193980
756	1.08768297
	193930
755	1.08574367
	193878
754	1.08380489
	193827
753	1.08186662
	193777
752	1.07992885
	193726
751	1.07799159

751	1.07799159
	193674
750	1.07605485
	193622
749	1.07411863
	193570
748	1.07218293
	193518
747	1.07024775
	193466
746	1.06831309
	193414
745	1.06637895
	193361
744	1.06444534
	193308
743	1.06251226
	193255
742	1.06057971
	193201
741	1.05864770
	193147
740	1.05671623
	193093
739	1.05478530
	193039
738	1.05285491
	192985
737	1.05092506
	192931
736	1.04899575
	192876
735	1.04706699
	192821

	192821
734	1.04513878
	192766
733	1.04321112
	192710
732	1.04128402
	192655
731	1.03935747
	192600
730	1.03743147
	192543
729	1.03550604
	192486
728	1.03358118
	192430
727	1.03165688
	192373
726	1.02973115
	192316
725	1.02780999
	172259
724	1.02588740
	192213
723	1.02396527
	192155
722	1.02204372
	192086
721	1.02012286
	192029
720	1.01820221
	191970
719	1.01628251
	191911
718	1.01436340

718	1.01436340
	191853
717	1.01244487
	191794
716	1.01052693
	191734
715	1.00860959
	191674
714	1.00669285
	191615
713	1.00477670
	191556
712	1.00286114
	191505
711	1.00094609
	191444
710	0.99903165
	191374
709	0.99711791
	191313
708	0.99520478
	191252
707	0.99329226
	191191
706	0.99138035
	191129
705	0.98946906
	191067
704	0.98755839
	191005
703	0.98564834
	190943
702	0.98273891
	190881
701	0.98183010

	190818	
700	0.97992192	
	190755	
699	0.97801437	
	190692	
698	0.97610745	
	190629	
697	0.97420116	
	190566	
696	0.97229550	
	190502	
695	0.97039048	
	190438	
694	0.96848610	
	190376	
693	0.96658234	
	190304	
692	0.96467930	
	190244	
691	0.96277686	
	190179	
690	0.96087497	
	190113	
689	0.95897384	
	190048	
688	0.95707336	
	189983	
687	0.95517353	
	189917	
686	0.95327436	
	189851	
685	0.95137585	
	189784	
684	0.94947801	
	189717	

	189717	
683	0.94758084	
	189651	
682	0.94568433	
	189584	
681	0.94378848	
	189516	
680	0.94189324	
	189448	
679	0.93999876	
	189381	
678	0.93810495	
	189313	
677	0.93621182	
	189244	
676	0.93431938	
	189176	
675	0.93242762	
	189107	
674	0.93053655	
	189038	
673	0.92864617	
	188969	
672	0.92675648	
	188899	
671	0.92486749	
	188823	
670	0.92297905	
	188769	
669	0.92109136	
	188696	
668	0.91920440	
	188619	
667	0.91731821	
	188549	

	188549
666	0. 91543272
	188478
665	0. 91354794
	188407
664	0. 91166387
	188336
663	0. 90978051
	188264
662	0. 90789787
	188192
661	0. 90601595
	188120
660	0. 90413479
	188048
659	0. 90225431
	187973
658	0. 90037458
	187900
657	0. 89849558
	187829
656	0. 89661729
	187757
655	0. 89473972
	187685
654	0. 89286287
	187610
653	0. 89098677
	187535
652	0. 88911142
	187461
651	0. 88723681
	187386
650	0. 88536295

650	0. 88536284
	187311
649	0. 88348973
	187237
648	0. 88161736
	187163
647	0. 87974573
	187087
646	0. 87787486
	187010
645	0. 87600476
	186934
644	0. 87413542
	186858
643	0. 87226684
	186782
642	0. 87039902
	186705
641	0. 86853197
	186628
640	0. 86666560
	186551
639	0. 86480009
	186473
638	0. 86293536
	186395
637	0. 86107141
	186317
636	0. 85920824
	186239
635	0. 85734585
	186161
634	0. 85548424
	186083
633	0. 85362341

633	0. 85362341
	186004
632	0. 85176337
	185924
631	0. 84990413
	185845
630	0. 84804557
	185764
629	0. 84618793
	185684
628	0. 84433109
	185606
627	0. 84247503
	185525
626	0. 84061978
	185444
625	0. 83876534
	185363
624	0. 83691171
	185281
623	0. 83505890
	185200
622	0. 83320690
	185119
621	0. 83135571
	185038
620	0. 82950517
	184956
619	0. 82765561
	184873
618	0. 82580688
	184790
617	0. 82395898
	184707
	184707
616	0. 82211191
	184624
615	0. 82026567
	184540
614	0. 81842027
	184456
613	0. 81657571
	184372
612	0. 81473199
	184288
611	0. 81288911
	184204
610	0. 81104695
	184119
609	0. 80920576
	184035
608	0. 80736541
	183949
607	0. 80552592
	183865
606	0. 80368727
	183780
605	0. 80184947
	183693
604	0. 80001254
	183606
603	0. 79817548
	183519
602	0. 79634029
	183433
601	0. 79450596
	183346
600	0. 79267250

600	0.79267345		583	0.76164040	
	183258			181734	
599	0.79084087		582	0.75982306	
	183170			181639	
598	0.78900917		581	0.75800667	
	183082			181543	
597	0.78717835		580	0.75619124	
	182994			181458	
596	0.78534841		579	0.75437670	
	182906			181365	
595	0.78351935		578	0.75256305	
	182818			181271	
594	0.78169117		577	0.75075934	
	182729			181178	
593	0.77986388		576	0.74893856	
	182640			181085	
592	0.77803748		575	0.74712771	
	182551			180991	
591	0.77621197		574	0.74531780	
	182461			180897	
590	0.77438736		573	0.74350883	
	182371			180802	
589	0.77256365		572	0.74170081	
	182281			180707	
588	0.77074084		571	0.73989374	
	182191			180611	
587	0.76891893		570	0.73708713	
	182100			180516	
586	0.76709793		569	0.73628197	
	182009			180422	
585	0.76527784		568	0.73447775	
	181918			180326	
584	0.76345866		567	0.73267449	
	131826			180230	

	180230
566	0. 73087219
	180134
565	0. 72907085
	180037
564	0. 72727048
	179940
563	0. 72547108
	279843
562	0. 72367265
	179745
561	0. 72187520
	179647
560	0. 72007866
	179548
559	0. 71828318
	179450
558	c. 71648868
	179353
557	0. 71469515
	179254
556	0. 71290261
	179155
555	0. 71111106
	179056
554	0. 70932050
	178956
553	0. 70753094
	178856
552	0. 70574238
	178755
551	0. 70395483
	178654
550	0. 70216829

550	0. 70216834
	178553
549	0. 70038281
	178452
548	0. 69859829
	178352
547	0. 69681477
	178250
546	0. 69503227
	178149
545	0. 69325078
	178048
544	0. 69147030
	177943
543	0. 68969087
	177841
542	0. 68791246
	177738
541	0. 68613508
	177634
540	0. 68435845
	177528
539	0. 68258317
	177423
538	0. 68080894
	177318
537	0. 67903576
	177218
536	0. 67726358
	177114
535	0. 67549244
	177009
534	0. 67372235
	176903

533	0.67195332
	176799
532	0.67018533
	176693
531	0.66841840
	176585
530	0.66665234
	176479
529	0.66488755
	176372
528	0.66312383
	176265
527	0.66136118
	176158
526	0.65959960
	176050
525	0.65783910
	175942
524	0.65607968
	175834
523	0.65432134
	175725
522	0.65256409
	175622
521	0.65080787
	175512
520	0.64905275
	175398
519	0.64729877
	175289
518	0.64554588
	175179
517	0.64379409
	175068

	175068
516	0.64204341
	174957
515	0.64029384
	174846
514	0.63854538
	174735
513	0.63679803
	174624
512	0.63505179
	174512
511	0.63330667
	174400
510	0.63156249
	174287
509	0.62981962
	174174
508	0.62807788
	174062
507	0.62633726
	173948
506	0.62459778
	173835
505	0.62285943
	173721
504	0.62112222
	173607
503	0.61938615
	173492
502	0.61765123
	173377
501	0.61591746
	173262
500	0.61418484

500	0. 61418485	483	0. 58490948
	173147		171136
499	0. 61245338	482	0. 58319809
	173031		171015
498	0. 61072307	481	0. 58148794
	172914		170893
497	0. 60899393	480	0. 57977892
	172798		170771
496	0. 60726595	479	0. 57807121
	172681		170649
495	0. 60553914	478	0. 57636472
	172564		170527
494	0. 60381350	477	0. 57465945
	172447		170406
493	0. 60208903	476	0. 57295539
	172329		170281
492	0. 60036574	475	0. 57125258
	172211		170158
491	0. 59864363	474	0. 56955100
	172093		170034
490	0. 59692260	473	0. 56785066
	171975		169910
489	0. 59520285	472	0. 56615156
	171856		169786
488	0. 59348429	471	0. 56445370
	171736		169661
487	0. 59176693	470	0. 56275702
	171617		169536
486	0. 59005076	469	0. 56106166
	171498		169411
485	0. 58833578	468	0. 55936755
	171377		169285
484	0. 58662201	467	0. 55767470
	171256		169159

	169159
466	0. 55598311
	169035
465	0. 55429278
	168901
464	0. 55260377
	168779
463	0. 55091598
	168652
462	0. 54922946
	168524
461	0. 54754422
	168397
460	0. 54586011
	168268
459	0. 54417743
	168139
458	0. 54249604
	168010
457	0. 54081594
	167881
456	0. 53913713
	167751
455	0. 53745962
	167621
454	0. 53578341
	167491
453	0. 53410850
	167360
452	0. 53243490
	167229
451	0. 53076261
	167098
450	0. 52909163

450	0. 52909295
	166966
449	0. 52742333
	166834
448	0. 52575499
	166702
447	0. 52408797
	166570
446	0. 52242227
	166437
445	0. 52075790
	166302
444	0. 51909488
	166168
443	0. 51743320
	166035
442	0. 51577285
	165900
441	0. 51411385
	165765
440	0. 51245467
	165634
439	0. 51079833
	165494
438	0. 50914339
	165358
437	0. 50748981
	165222
436	0. 50583759
	165086
435	0. 50418673
	164949
434	0. 50253724
	164811

433	0.50088913	
		164673
432	0.49924240	
		164535
431	0.49759705	
		164397
430	0.49595308	
		164259
429	0.49431049	
		164120
428	0.49266929	
		163980
427	0.49102949	
		163835
426	0.48939114	
		163700
425	0.48775414	
		163560
424	0.48611854	
		163419
423	0.48448435	
		163277
422	0.48285158	
		163135
421	0.48122023	
		162998
420	0.47959025	
		162843
419	0.47796165	
		162708
418	0.47633457	
		162565
417	0.47470892	
		162422

		162422
416	0.47308470	
		162278
415	0.47146192	
		162134
414	0.46984058	
		161989
413	0.46822069	
		161844
412	0.46660225	
		161699
411	0.46498526	
		161570
410	0.46336957	
		161410
409	0.46175547	
		161260
408	0.46014287	
		161113
407	0.45853174	
		160966
406	0.45692208	
		160818
405	0.45531390	
		160670
404	0.45370720	
		160522
403	0.45210198	
		160373
402	0.45049825	
		160223
401	0.44889602	
		160073
400	0.44729529	

400	0.44729522		
	159923		
399	0.44569599		
	159773		
398	0.44409826		
	159623		
397	0.44250203		
	159472		
396	0.44090731		
	159320		
395	0.43931411		
	159168		
394	0.43772243		
	159016		
393	0.43613227		
	158863		
392	0.43454364		
	158710		
391	0.43295654		
	158557		
390	0.43137086		
	158403		
389	0.42978683		
	158248		
388	0.42820435		
	158093		
387	0.42662342		
	157938		
386	0.42504404		
	157782		
385	0.42346622		
	157626		
384	0.42188996		
	157470		

383	0.42031526		
	157313		
382	0.41874213		
	157156		
381	0.41717057		
	156999		
380	0.41560058		
	156841		
379	0.41403217		
	156682		
378	0.41246535		
	156522		
377	0.41090013		
	156363		
376	0.40933650		
	156204		
375	0.40777446		
	156044		
374	0.40621402		
	155883		
373	0.40465519		
	155722		
372	0.40309797		
	155561		
371	0.40154236		
	155399		
370	0.39998818		
	155238		
369	0.39843580		
	155025		
368	0.39688555		
	154911		
367	0.39533644		
	154788		

	154788
366	0. 39378896
	154584
365	0. 39224312
	154419
364	0. 39069893
	154254
363	0. 38915639
	154089
362	0. 38761550
	153923
361	0. 38607627
	153757
360	0. 38453683
	153591
359	0. 38300092
	153424
358	0. 38 46668
	153256
357	0. 37993412
	153088
356	0. 37840324
	152920
355	0. 37687404
	152751
354	0. 37534653
	152582
353	0. 37382071
	152443
352	0. 37229658
	152242
351	0. 37077416
	152075
350	0. 36925315

350	0. 36925312
	151905
349	0. 36773407
	151728
348	0. 36621679
	151556
347	0. 36470123
	151384
346	0. 36318739
	151211
345	0. 36167528
	151038
344	0. 36016490
	150865
343	0. 35865625
	150690
342	0. 35714935
	150515
341	0. 35564420
	150340
340	0. 35414227
	150164
339	0. 35264063
	149988
338	0. 35114075
	149811
337	0. 34964264
	149634
336	0. 34814630
	149457
335	0. 34665173
	149279
334	0. 34515894
	149100

333	0. 34366794
	148921
332	0. 34217873
	148742
331	0. 34069131
	148562
330	0. 33920561
	148381
329	0. 33772180
	148200
328	0. 33623980
	148024
327	0. 33475956
	147842
326	0. 33328114
	147663
325	0. 33180451
	147480
324	0. 33032971
	147288
323	0. 32885683
	147104
322	0. 32738579
	146919
321	0. 32591660
	146735
320	2. 32444946
	146550
319	0. 32298396
	146362
318	0. 32152034
	146175
317	0. 32005859
	145990

	145990
316	0. 31859869
	145803
315	0. 31714066
	145614
314	0. 31568452
	145425
313	0. 31423027
	145236
312	0. 31277791
	145047
311	0. 31132744
	144856
310	0. 30987884
	144665
309	2. 30843219
	144474
308	0. 30698745
	144282
307	0. 30554463
	144090
306	0. 30410373
	143897
303	0. 30266476
	143703
304	0. 30122773
	143508
303	0. 29978265
	143315
302	0. 29835950
	143120
301	0. 29692830
	142926
300	0. 29549904

300	0. 29549884
	142730
299	0. 29407154
	142533
298	0. 29264621
	142335
297	0. 29122286
	142137
296	0. 28980149
	141939
295	0. 28838210
	141741
294	0. 28696469
	141460
293	0. 28555009
	141260
292	0. 28413749
	141191
291	0. 28272558
	140990
290	0. 28131493
	140730
289	0. 27990763
	140527
288	0. 27850236
	140331
287	0. 27709905
	140124
286	0. 27569781
	139920
285	0. 27429861
	139720
284	0. 27290141
	139517

283	0. 27150624
	139311
282	0. 27011313
	139105
281	0. 26872208
	138898
280	0. 26733268
	138690
279	0. 26594578
	138482
278	0. 26456096
	138273
277	0. 26317823
	138063
276	0. 26179760
	137853
275	0. 26041907
	137643
274	0. 25904264
	137432
273	0. 25766832
	137220
272	0. 25629612
	137008
271	0. 25492604
	136795
270	0. 25355796
	136583
269	0. 25219213
	136370
268	0. 25082843
	136153
267	0. 24946690
	135936

	135936
266	0. 24810754
	135720
265	0. 24675034
	135504
264	0. 24539530
	135287
263	0. 24404243
	135069
262	0. 24269174
	134850
261	0. 24134324
	134553
260	0. 23999689
	134333
259	0. 23865356
	134189
258	0. 23731165
	133968
257	0. 23597197
	133746
256	0. 23463451
	133523
255	0. 23329928
	133300
254	0. 23196628
	133076
253	0. 23063552
	132801
252	0. 22930751
	132575
251	0. 22798176
	132399
250	0. 22665777

250	0. 22665594
	132173
249	0. 22533421
	131946
248	0. 22401475
	131718
247	0. 22269757
	131488
246	0. 22138269
	131259
245	0. 22007010
	131029
244	0. 21875981
	130799
243	0. 21745182
	130567
242	0. 21614615
	130334
241	0 21484281
	130101
240	0. 21354168
	129867
239	0. 21224301
	129632
238	0. 21094669
	129396
237	0. 20965273
	129160
236	0. 20836113
	128924
235	0. 20707189
	128688
234	0. 20578501
	128449

233	0.20450052
	128208
232	0.20321844
	123968
231	0.20193876
	127729
230	0.20066138
	127488
229	0.19938650
	127245
228	0.19811405
	127002
227	0.19684403
	126758
226	0.19557645
	126514
225	0.19431131
	126269
224	0.19304862
	126023
223	0.19178839
	125776
222	0.19053063
	125528
221	0.18927535
	125279
220	0.18802248
	125027
219	0.18677221
	124777
218	0.18552444
	124529
217	0.18427915
	124278
	124278
216	0.18303637
	124025
215	0.18179612
	123771
214	0.18055841
	123517
213	0.17932324
	123262
212	0.17809062
	123006
211	0.17686056
	122749
210	0.17563291
	122490
209	0.17440801
	122232
208	0.17318569
	122974
207	0.17196595
	121713
206	0.17074882
	121451
205	0.16953431
	121189
204	0.16832242
	120926
203	0.16711316
	120663
202	0.16590653
	120399
201	0.16470254
	120133
200	0.16350121

200	0. 16350111		183	0. 14349427	
	119866			115084	
199	0. 16230245		182	0. 14234243	
	119598			114900	
198	0. 16110647		181	0. 14119343	
	119329			114615	
197	0. 15991318		180	0. 14004728	
	119959			114328	
196	0. 15872259		179	0. 13890400	
	118789			114040	
195	0. 15753479		178	0. 13776354	
	118518			113752	
194	0. 15634952		177	0. 13612602	
	118246			163462	
193	0. 15516706		176	0. 13549140	
	117972			113164	
192	0. 15398733		175	0. 13435926	
	117698			112873	
191	0. 15281035		174	0. 13323103	
	117422			112587	
190	0. 15163596		173	0. 13210516	
	117146			112292	
189	0. 15046450		172	0. 13098224	
	116869			111996	
188	0. 14929581		171	0. 12986228	
	116591			111700	
187	0. 14812990		170	0. 12874498	
	116312			111403	
186	0. 14696678		169	0. 21763088	
	116032			111105	
185	0. 14580646		168	0. 12651983	
	115751			110805	
184	0. 14464895		167	0 .12541178	
	115468			110503	

	110503	
166	0. 12430675	
	110200	
165	0. 12320475	
	109896	
164	0. 12210579	
	109592	
163	0. 12100987	
	109287	
162	0. 11991700	
	108980	
161	0. 11882720	
	108671	
160	0. 11774053	
	108361	
159	0. 11665692	
	108047	
158	0. 11557645	
	107735	
157	0. 11449910	
	107425	
156	0. 11342485	
	107110	
155	0. 11235375	
	106794	
154	0. 11128581	
	106478	
153	0. 11022103	
	106159	
152	0. 10915944	
	105838	
151	0. 10810106	
	105517	
150	0. 10704589	

150	0. 10704589	
	105194	
149	0. 10599395	
	104870	
148	0. 10494525	
	104545	
147	0. 10389980	
	104218	
146	0. 10285762	
	105889	
145	0. 10181873	
	103560	
144	0. 10078313	
	103229	
143	0. 09975084	
	102895	
142	0. 09872199	
	102561	
141	0. 09769638	
	102213	
140	0. 09667379	
	101876	
139	0. 09565503	
	101550	
138	0. 09463953	
	101210	
137	0. 09362743	
	100869	
136	0. 09261874	
	100526	
135	0. 09161348	
	100181	
134	0. 09061167	
	99834	

133	0.08961333	
	99461	
132	0.08861872	
	99112	
131	0.08762760	
	98786	
130	0.08663902	
	98433	
129	0.08565469	
	98078	
128	0.08467391	
	97722	
127	0.08369669	
	97364	
126	0.08272305	
	97004	
125	0.08175301	
	96643	
124	0.08078658	
	96280	
123	0.07982378	
	95915	
122	0.07886463	
	95548	
121	0.07790915	
	95179	
120	0.07695736	
	94811	
119	0.07600925	
	94438	
118	0.07506487	
	94061	
117	0.07412426	
	93685	

	93685	
116	0.07318741	
	93307	
115	0.07225434	
	92901	
114	0.07132533	
	92524	
113	0.07040009	
	92161	
112	0.06947848	
	91774	
111	0.06856074	
	91386	
110	0.06764629	
	90944	
109	0.06673685	
	90551	
108	0.06583134	
	90208	
107	0.06492926	
	89811	
106	0.06403115	
	89412	
105	0.06313703	
	89011	
104	0.06224692	
	88608	
103	0.06136084	
	88202	
102	0.06047882	
	87793	
101	0.05960089	
	87382	
100	0.05872707	

100	0.05872590
	86969
99	0.05785621
	86554
98	0.05699067
	86137
97	0.05612930
	85717
96	0.05527213
	85293
95	0.05441920
	84867
94	0.05357053
	84440
93	0.05272613
	84010
92	0.05188603
	83666
91	0.05104937
	83229
90	0.05121866
	82700
89	0.04939166
	82259
88	0.04856907
	81814
87	0.04775093
	81366
86	0.04693727
	80916
85	0.04612811
	89462
84	0.04532349
	80005

83	0.04452344
	79545
82	0.04372799
	79083
81	0.04293716
	78617
80	0.04215095
	78147
79	0.04136948
	77674
78	0.04058274
	77197
77	0.03982077
	76707
76	0.03905370
	76224
75	0.03829146
	75748
74	0.03753398
	75250
73	0.03678140
	74764
72	0.03603376
	34265
71	0.03529111
	73752
70	0.03455313
	73246
69	0.03382067
	72746
68	0.03309321
	72232
67	0.03237089
	71716

	71716
66	0.03165373
	71193
65	0.03094180
	70664
64	0.03023516
	70132
63	0.02953384
	69595
62	0.02883789
	69054
61	0.02814735
	68508
60	0.02746204
	67961
59	0.02928243
	67405
58	0.02610838
	66840
57	0.02543998
	66273
56	0.02477725
	65701
55	0.02412024
	65123
54	0.02346901
	64539
53	0.02282362
	63950
52	0.02218412
	63353
51	0.02155059
	62750
50	0.02092309

50	0.02092302
	62143
49	0.02030159
	61528
48	0.01968631
	60906
47	0.01907725
	60277
46	0.01847448
	59640
45	0.01787808
	58996
44	0.01728812
	58344
43	0.01670468
	57683
42	0.01612784
	57016
41	0.01555768
	56340
40	0.01499411
	55655
39	0.01443756
	54960
38	0.01388796
	54256
37	0.01334540
	53540
36	0.01281000
	52815
35	0.01228185
	52079
34	0.01176106
	51331

33	0.01124776		36176
	50572	16	0.00380718
32	0.01074204		35071
	49801	15	0.00345647
31	0.01024403		33929
	49016	14	0.00311718
30	0.00975364		32746
	48217	13	0.00278972
29	0.00927147		31517
	47405	12	0.00247455
28	0.00879742		30236
	46578	11	0.00217219
27	0.00833164		28897
	45734	10	0.00188278
26	0.00787430		27442
	44874	9	0.00160836
25	0.00742556		25959
	43997	8	0.00134877
24	0.00698559		24434
	43102	7	0.00110443
23	0.00655457		22749
	42185	6	0.00087694
22	0.00613272		20925
	41244	5	0.00066769
21	0.00572028		18922
	40273	4	0.00047847
20	0.00531730		16675
	39291	3	0.00031172
19	0.00492439		14061
	38297	2	0.00017111
18	0.00454142		10792
	37248	1	0.00006319
17	0.00416894		6319
	36176	0	0.00000000

Jas. Burgess.

A

TABLE

SHEWING THE

AREA

OF THE

SEGMENTS

OF A

CIRCLE

WHOSE

Whole Area is Unity, to the ten Thousandth part of the Diameter.

	0	1	2	3	4
0	000000	000004	000007	000011	000014
1	000053	000062	000071	000080	000089
2	000151	000163	000175	000187	000200
3	000278	000292	000307	000322	000336
4	000428	000444	000461	000478	000494
5	000599	000617	000636	000654	000673
6	000787	000807	000827	000847	000867
7	000991	001012	001034	001056	001077
8	001211	001234	001257	001280	001304
9	001445	001469	001494	001518	001542
10	001692	001717	001743	001769	001794
11	001952	001979	002005	002032	002059
12	002223	002251	002279	002307	002335
13	002506	002535	002564	002593	002623
14	002700	002830	002860	002890	002921
15	003105	003136	003167	003198	003229
16	003419	003451	003483	003515	003548
17	003743	003776	003809	003842	003876
18	004077	004111	004145	004179	004213
19	004420	004455	004490	004525	004560
20	004770	004806	004843	004879	004915
21	005133	005170	005206	005243	005280
22	005502	005539	005577	005615	005652
23	005880	005918	005957	005995	006023
24	006266	006305	006344	006383	006423
25	006660	006700	006739	006779	006819
26	007061	007102	007142	007183	007223
27	007470	007511	007553	007594	007635
28	007886	007928	007970	008012	008055
29	008310	008353	008396	008439	008482
30	008741	008785	008828	008872	008916
31	009179	009223	009267	009312	009356
32	009624	009669	009714	009759	009804
33	010075	010121	010167	010212	010258

5	6	7	8	9	
000018	000025	000032	000039	000046	
000098	000108	000119	000130	000140	
000212	000225	000238	000251	000265	
000351	000366	000382	000397	000413	
000511	000529	000546	000564	000581	
000691	000710	000729	000748	000768	19
000887	000908	000928	000949	000970	20
001099	001121	001144	001166	001188	21
001327	001350	001374	001398	001421	23
001567	001592	001617	001642	001667	25
001820	001846	001873	001899	001925	26
002086	002113	002141	002168	002195	27
002363	002392	002420	002449	002477	28
002652	002681	002711	002741	002770	29
002951	002982	003013	003043	003074	30
003260	003291	003323	003355	003387	31
003580	003612	003645	003678	003710	32
003909	003942	003976	004009	004043	33
004247	004281	004316	004351	004385	34
004595	004630	004665	004700	004735	35
004952	004988	005024	005061	005097	36
005317	005354	005391	005428	005465	37
005690	005728	005766	005804	005842	38
006072	006111	006150	006188	006227	39
006462	006501	006541	006581	006620	39
006859	006899	006940	006980	007021	40
007264	007305	007346	007387	007429	41
007677	007719	007761	007802	007844	42
008097	008140	008182	008225	008267	42
008525	008568	008611	008654	008698	43
008959	009203	009047	009091	009135	44
009400	009445	009490	009535	009579	45
009849	009894	009939	009985	010030	45
010303	010349	010395	010441	010487	46

	0	1	2	3	4
33	010075	010121	010167	010212	010258
34	010533	010580	010626	010672	010719
35	010999	011045	011093	011139	011186
36	011469	011517	011565	011612	011660
37	011947	011995	012043	012092	012140
38	012431	012479	012528	012577	012626
39	012921	012970	013020	013069	013118
40	013417	013467	013517	013567	013617
41	013919	013969	014020	014071	014121
42	014426	014478	014529	014580	014632
43	014941	014992	015044	015096	015148
44	015460	015512	015565	015617	015669
45	015985	016038	016091	016144	016197
46	016515	016569	016622	016676	016729
47	017052	017906	017160	017214	017268
48	017593	017648	017703	017757	017812
49	018141	018196	018251	018306	018361
50	018693	018749	018804	018860	018916
51	019251	019307	019363	019419	019475
52	019813	019870	019927	019984	020040
53	020381	020439	020496	020553	020610
54	020954	021012	021070	021128	021185
55	021532	021590	021649	021707	021765
56	022115	022174	022233	022292	022350
57	022703	022763	022822	022881	022949
58	023296	023356	023415	023475	023534
59	023894	023954	024014	024074	024134
60	024496	024557	024617	024678	024738
61	025103	025164	025225	025286	025347
62	025715	025776	025838	025899	025961
63	026331	026393	026455	026517	026579
64	026952	027015	027077	027140	027202
65	027578	027641	027704	027767	027830
66	028208	028271	028335	028398	028461

5	6	7	8	9	
010303	010349	010395	010441	010487	46
010765	010812	010858	010905	010952	47
011233	011281	011328	011375	011422	47
011707	011755	011803	011851	011899	47
012188	012237	012285	012334	012382	48
012675	012724	012773	012823	012872	49
013168	013218	013267	013317	013367	50
013667	013717	013767	013818	013868	50
014172	014223	014274	014325	014375	51
014683	014734	014786	014837	014889	51
015199	015252	015304	015356	015408	52
015721	015774	015827	015879	015932	52
016249	016303	016356	016409	016462	53
016783	016837	016891	016944	016998	54
017322	017376	017431	017485	017539	54
017866	017921	017976	018031	018086	55
018416	018471	018527	018582	018638	55
018971	019027	019083	019139	019195	56
019531	019588	019644	019701	019757	56
020097	020154	020211	020268	020325	57
020667	020725	020782	020840	020897	57
021243	021301	021359	021416	021474	57
021823	021882	021940	021999	022057	58
022409	022468	022527	022586	022645	59
022999	023058	023118	023177	023237	59
023594	023654	023714	023774	023834	60
024194	024254	024315	024375	024436	60
024799	024860	024921	024981	025042	60
025408	025470	025531	025692	025654	61
026022	026084	026146	026208	026270	62
026641	026703	026766	026828	026890	62
027264	027327	027390	027453	027515	63
027892	027956	028019	028082	028145	63
028524	028588	028652	028715	028779	63

	0	1	2	3	4
67	028842	028906	028970	029034	029097
68	029481	029545	029610	029674	029738
69	030184	030189	030253	030318	030383
70	030772	030837	030902	030967	031032
71	031424	031489	031555	031620	031686
72	032080	032146	032212	032278	032344
73	032741	032807	032873	032939	033006
74	033405	033472	033538	033605	033672
75	034073	034140	034208	034275	034342
76	034746	034814	034881	034949	035016
77	035423	035491	035559	035627	035695
78	036104	036172	036249	036309	036378
79	036789	036858	036927	036995	037064
80	037477	037546	037615	037684	037752
81	038169	038239	038308	038378	038447
82	038867	038937	039007	039077	039147
83	039568	039638	039709	039779	039849
84	040272	040343	040414	040485	040555
85	040981	041052	041123	041194	041265
86	041692	041764	041835	041907	041978
87	042408	042480	042552	042624	042696
88	043128	043200	043272	043345	043417
89	043852	043924	043697	044069	044142
90	044578	044651	044724	044797	044870
91	045309	045382	045456	045529	045603
92	046043	046117	046190	046264	046338
93	046781	046855	046929	047003	047077
94	047522	047596	047671	047745	047819
95	048267	048342	048417	048491	048566
96	049015	049091	049166	049241	049316
97	049767	049843	049918	049994	050069
98	050522	050598	050674	050750	050826
99	051281	051358	051434	051510	051586
100	052044	052120	052197	052273	052350

5	6	7	8	9	
029161	029225	029289	029353	029417	64
029802	029867	029931	029996	030060	65
030447	030512	030577	030642	030707	65
031097	031163	031228	031293	031359	65
031751	031817	031883	031949	032014	66
032409	032476	032542	032608	032674	66
033072	033139	033205	033272	033338	66
033738	033875	033879	033939	034006	67
034409	034477	034544	034612	034679	67
035084	035152	035219	035287	035355	68
035763	035831	035899	035968	036036	68
036446	036515	036583	036651	036720	69
037133	037202	037271	037339	037408	69
037822	037891	037961	038030	038099	69
038517	038587	038657	038727	038797	70
039217	039287	039357	039428	039498	70
039919	039990	040061	040131	040202	71
040636	040707	040778	040849	040920	71
041336	041407	041479	041550	041621	71
042050	042122	042193	042265	042336	72
042768	042840	042912	042984	043056	72
043489	043562	043634	043706	043779	73
044214	044287	044360	044433	044505	73
044943	045016	045089	045163	045236	73
045676	045749	045823	045896	045969	74
046411	046485	046559	046633	046707	74
047151	047225	047299	047374	047448	74
047894	047969	048043	048118	048192	75
048641	048716	048791	048866	048941	75
049391	049466	049542	049617	049692	75
050144	050226	050296	050371	050447	75
050901	050977	051053	051129	051205	76
051662	051738	051815	051891	051968	76
052426	052503	052579	052656	052733	76

	0	1	2	3	4
100	052044	052120	052197	052273	052350
101	052810	052886	052963	053040	053117
102	053579	053656	053733	053810	053887
103	054351	054428	054506	054583	054661
104	055127	055204	055282	055360	055438
105	055906	055984	056062	056140	056218
106	056688	056766	056845	056923	057002
107	057474	057552	057631	057710	057789
108	058262	058341	058420	058499	058578
109	059054	059133	059213	059292	059372
110	059849	059929	060009	060088	060168
111	060648	060728	060808	060888	060968
112	061449	061529	061610	061690	061771
113	062254	062334	062415	062496	062576
114	063062	063143	063224	063305	063386
115	063873	063954	064035	064116	064198
116	064686	064768	064849	064931	065013
117	065503	065585	065667	065749	065831
118	066323	066405	066488	066570	066652
119	067146	067229	067311	067393	067476
120	067972	068055	068138	068221	068304
121	068801	068884	068967	069051	069134
122	069633	069717	069800	069884	069967
123	070468	070552	070635	070719	070803
124	071306	071390	071474	071558	071642
125	072148	072232	072316	072400	072484
126	072991	073075	073160	073244	073329
127	073837	073922	074007	074092	074177
128	074687	074772	074857	074942	075027
129	075539	075624	075709	075795	075880
130	076394	076479	076565	076651	076736
131	077251	077337	077423	077509	077595
132	078112	078198	078184	078370	078457
133	078975	079062	079148	079235	079321

5	6	7	8	9	D
052426	052503	052579	052656	052733	076
053193	053271	053348	053425	053502	077
053964	054041	054119	054196	054273	077
054738	054816	054893	054973	055049	078
055516	055594	055672	055750	055828	078
056296	056374	056453	006531	056610	078
057080	057159	057237	057316	057395	079
057868	057946	058025	058104	058183	079
058658	058737	058816	058895	058975	079
059451	059531	059610	059690	059769	079
060248	060328	060408	060488	060560	080
061048	061128	061208	061289	061369	080
061851	061932	062012	062093	062173	080
062657	062738	062819	062900	062981	081
063467	063548	063629	063710	063791	081
064279	064360	064442	064523	064605	081
065095	065176	065258	065340	065421	082
065913	065995	066077	066159	066241	082
066735	066817	066899	066981	067064	082
067559	067642	067724	067807	067889	083
068387	068469	068552	068635	068718	083
069217	069300	069384	069467	069550	083
070051	070134	070218	070301	070385	083
070887	070970	071054	071138	071222	084
071726	071810	071895	071979	072063	084
072569	072653	072733	072822	072906	084
073414	073498	073583	073668	073752	084
074262	074347	074432	074517	074602	085
075112	075197	075283	075368	075453	085
075966	076051	076137	076222	076908	085
076822	076908	076994	077079	077165	086
077681	077767	077853	077939	078025	086
078543	078629	078716	078802	078889	086
079408	079494	079581	079668	079754	086

	0	1	2	3	4
133	078975	079062	079148	079235	079321
134	079841	079928	080015	080101	080188
135	080710	080797	080885	080972	081059
136	081582	081669	081756	081841	081931
137	082456	082543	082631	082718	082806
138	083333	083420	083508	083596	083684
139	084212	084300	084388	084477	084565
140	085095	085183	085271	085359	085448
141	085979	086068	086157	086246	086334
142	086867	086956	087045	087134	087223
143	087757	087846	087935	088025	088114
144	088650	088740	088829	088920	089009
145	089545	089635	089725	089814	089904
146	090444	090533	090623	090713	090803
147	091344	091434	091524	091614	091704
148	092247	092337	092427	092518	092608
149	093152	093243	093333	093424	093515
150	094060	094151	094242	094333	094424
151	094971	095062	095153	095244	095335
152	095884	095975	096067	096158	096249
153	096799	096891	096982	097074	097166
154	097717	097809	097901	097993	098085
155	098637	098729	098822	098914	099006
156	099569	099653	099745	099838	099830
157	100486	100578	100671	100763	100856
158	101413	101506	101599	101692	101785
159	102343	102436	102529	102622	102715
160	103275	103368	103462	103555	103649
161	104210	104304	104397	104491	104584
162	105147	105241	105335	105429	105523
193	106087	106181	106275	106369	106463
164	107028	107122	107217	107311	107406
165	107972	108067	108161	108256	108350
166	108919	109013	109108	109203	109298

5	6	7	8	9	D
079408	079494	079581	079668	079754	086
080275	080362	080449	080536	080623	087
081147	081234	081321	081408	081495	087
032018	082106	082193	082281	082368	087
082894	082981	083069	083157	083245	087
083772	083860	083948	084036	084124	088
084653	084741	084830	084918	085006	088
085536	085625	085714	085802	085891	088
086423	086512	086601	086689	086778	089
087312	087401	087490	087579	087668	089
088203	088292	088383	088471	088561	089
089099	089188	089278	089365	089456	090
089994	090084	090174	090264	090354	090
090893	090983	091073	091163	091253	90
091795	091885	091975	092066	092156	90
092699	092790	092880	092971	093061	90
093606	093696	093787	093878	093969	91
094515	094606	094697	094788	094879	91
095427	095518	095609	095701	095792	91
096341	096433	096524	096616	096707	92
097258	097349	097441	097533	097625	92
098177	098269	098361	098453	098545	92
099098	099191	099283	099375	099468	92
100023	100115	100208	100300	100393	93
100949	101042	101135	101227	101320	93
101878	101971	102064	102157	101250	93
102809	102902	102995	103088	103182	93
103742	103836	103929	104023	104116	93
104678	104772	104866	104959	105053	94
105617	105711	105805	105899	105991	94
106557	106651	106745	106840	106934	94
107500	107594	107689	107783	107878	94
108445	108540	108634	108727	108824	95
109393	109488	109583	109678	109773	95

	0	1	2	3	4
166	108919	109013	109108	109203	109298
167	109867	109963	110058	110153	110248
168	110818	110913	111009	111104	111295
169	111772	111867	111963	112058	112154
170	112726	112822	112918	113013	113109
171	113684	113780	113876	113972	114068
172	114644	114740	114836	114932	115028
173	115607	115703	115799	115896	115992
174	116570	116666	116763	116860	116956
175	117536	117633	117730	117827	117924
176	118506	118603	118700	118797	118894
177	119476	119574	119671	119768	119866
178	120449	120547	120644	120742	120839
179	121424	121562	121620	121717	121815
180	122402	122500	122597	122696	122794
181	123382	123480	123578	123676	123774
182	124363	124461	124560	124658	124756
183	125347	125445	125544	125642	125741
184	126333	126432	126530	126629	126728
185	127320	127419	127518	127617	127716
186	128310	128409	128508	128607	128706
187	129302	129401	129500	129600	129699
188	130296	130395	130495	130594	130694
189	131292	131392	131491	131591	131691
190	132290	132390	132490	132590	132690
191	133290	133390	133490	133590	133690
192	134292	134392	134492	134593	134693
193	135296	135396	135497	135597	135697
194	136302	136402	136503	136604	136704
195	137310	137410	137511	137612	137713
196	138320	138421	138522	138623	138724
197	139331	139432	139534	139635	139737
198	140345	140447	140548	140650	140751
199	141361	141462	141564	141665	141767

5	6	7	8	9	D
109392	109487	109683	109677	109773	95
110343	110438	110533	110628	110723	95
111390	111485	111485	111581	111676	95
112249	112344	112440	112535	112631	96
113205	113301	113397	113492	113588	96
114164	114260	114356	114452	114548	96
115125	115221	115318	115414	115511	96
116088	116184	116281	116377	116473	97
117053	117150	117246	117343	117439	97
118021	118118	118215	118312	118409	97
118991	119088	119185	119282	119379	97
119963	120060	120158	120255	120352	97
120936	121034	121132	121229	121327	98
121913	122010	122108	122206	122304	98
122892	122990	123088	123186	123284	98
123872	123970	124068	124167	124265	98
124855	124953	125051	125150	125248	98
125840	125938	126037	126136	126234	98
126827	126925	127024	127123	127221	99
127815	127914	128013	128112	128211	99
128805	128905	129004	129103	129202	99
129799	129897	139997	130096	130196	99
130794	130893	130993	131093	131192	100
131791	131890	131990	132090	132190	100
132790	132890	132990	133090	133190	100
133790	133890	133990	134090	134191	100
134794	134894	134994	135095	135195	100
135798	135899	135999	136100	136201	101
136805	136906	137007	137108	137209	101
137814	137915	138016	138117	138218	101
138825	138926	139027	139129	139230	101
139838	139939	140041	140142	140244	101
140853	140954	141055	141157	141259	101
141869	141970	142072	142174	142276	102

D	0	1	2	3	4
200	142378	142480	142582	142684	142786
201	143398	142500	143602	143704	143806
202	144419	144521	144624	144726	144828
203	145443	145545	145648	145750	145853
204	146468	146571	146673	146776	146878
205	147495	147598	147701	147803	147906
206	148524	148627	148730	148833	148936
207	149555	149658	149761	149864	149967
208	150588	150691	150794	150898	151001
209	151623	151726	151829	151933	151037
210	152659	152762	152866	152970	153074
211	153696	153800	153903	154009	154111
212	154736	154840	154944	155048	155152
213	155778	155882	155987	156092	156195
214	156822	156926	157030	157135	157239
215	157867	157971	158076	158180	158285
216	158914	159018	159123	159228	159333
217	159963	160068	160173	160278	160383
218	161013	161118	161223	161329	161434
219	162065	162170	162276	162387	162487
220	163119	163225	163330	163436	163542
221	164176	164281	164387	164493	164598
222	165233	165339	165445	165550	165656
223	166292	166398	166504	166610	166716
224	167353	167459	167565	167672	167778
225	168415	168521	168521	168734	168841
226	169479	169586	169692	169799	169905
227	170545	170652	170758	170865	170972
228	171613	171719	171826	171933	172040
229	172682	172789	172896	173003	173110
230	173753	173860	173967	174074	174181
231	174825	174932	175040	175147	175255
232	175899	176007	176114	176222	176329
233	176975	177082	177190	177298	177405

5	6	7	8	9	D
142888	142990	143092	143194	143296	102
143909	144011	144113	144215	144317	102
144931	145033	145135	145238	145340	102
145955	146058	146160	146263	146365	102
146981	147084	147187	147289	147392	102
148009	148112	148215	148318	141421	103
149039	149142	149245	149348	149451	103
150071	150174	150277	150387	150484	103
151105	151208	151312	151415	151519	103
152141	152244	152348	152452	152555	103
153178	153281	153385	153489	153592	103
154215	154319	154423	154523	154632	103
155257	155361	155465	155569	155674	104
156300	156404	156508	156613	156717	104
157344	157448	157553	157657	157762	104
158390	158494	158599	158704	158809	105
159438	159453	159648	159753	159858	105
160488	160593	160698	160803	160908	105
161539	161644	161749	161855	161959	105
162592	162697	162803	162908	162014	105
163648	163753	163859	163964	164070	106
164704	164810	164916	165021	165127	106
165762	165868	165974	166080	166186	106
166822	166928	167034	167141	167247	106
167884	167990	168096	168203	168309	106
168947	169053	169160	169266	169373	107
170012	170119	170225	120332	170438	107
171079	171185	171292	171399	171506	107
172147	172254	172361	172468	172575	107
173217	173324	173431	173538	173645	107
174289	174396	174503	174610	174718	107
175362	175469	175577	175684	175792	107
176437	176544	176652	176759	176867	108
177513	177621	177729	177836	177944	108

D	0	1	2	3	4
233	176975	177082	177190	177298	177405
234	178052	178160	178268	178375	178483
235	179131	179239	179347	179455	179563
236	180212	180320	180428	180536	180644
237	181294	181402	181510	181618	181727
238	182377	182486	182594	182703	182811
239	183462	183571	183680	183788	183897
240	184549	184658	184767	184875	184984
241	185637	185746	185855	185964	186073
242	186728	186837	186946	187055	187164
243	187819	187928	188037	188146	188256
244	188911	189021	189130	189240	189349
245	199006	190116	190225	190335	190444
246	191102	191212	191322	191431	191541
247	192200	192310	192420	192529	192639
248	193298	193408	193518	193628	193738
249	194399	194509	194619	194729	194839
250	195500	195611	195721	195831	195942
251	196605	196715	196826	196936	197047
252	197710	197821	197931	198041	198152
253	198815	198926	199037	199148	199258
254	199923	200034	200145	200256	200367
255	201032	201144	201255	201366	201477
256	202143	202254	202365	202477	202588
257	203255	203366	203478	203589	203700
258	204368	204480	204591	204703	204814
259	205483	205595	205707	205818	205930
260	206599	206711	206823	206935	207047
261	207717	207829	207941	208053	208165
262	208836	208948	209060	209172	209284
263	209957	210069	210181	210293	210405
264	211078	211191	211303	211415	211528
265	212202	212314	212427	212539	212651
266	213326	213439	213552	213665	213778

5	6	7	8	9	
177513	177621	177729	177836	177944	108
178591	178699	178807	178915	179027	108
179672	179780	179888	179996	180104	108
180752	180860	180969	181077	181085	108
181835	181943	182052	182160	182269	108
182920	183028	183137	183245	183354	108
184006	184114	184223	184332	184440	109
185093	185202	185311	185419	185528	109
186182	186291	186400	186509	186618	109
187273	187382	187491	187600	187709	109
188365	188474	188584	188693	188802	109
189458	189568	189677	189787	189896	109
190554	190664	190773	190883	190992	110
191651	191761	191871	191980	192090	110
192749	192859	192969	193079	193189	110
193848	193958	194068	194178	194288	110
194949	195059	195169	195279	195389	110
196052	196163	196273	196384	196494	110
197157	197268	197378	197489	197599	110
198262	198373	198484	198594	198705	110
199369	199480	199591	199701	199812	111
200478	200588	200699	200811	200921	111
201587	201699	201810	201921	202032	111
202699	202810	202921	203033	203144	111
203811	203922	204033	204145	204256	111
204926	205037	205149	205261	205372	111
206041	206153	206264	206376	206488	112
207158	207270	207382	207494	207606	112
208277	208389	208501	208613	208725	112
209396	209508	209620	209733	209845	112
210517	210630	210742	210854	210966	112
211640	211752	211865	211977	212089	112
212763	212876	212989	213101	213214	112
222891	214003	214115	214227	214340	113

	0	1	2	3	4
266	213326	213439	213552	213665	213778
267	214452	214565	214677	214780	214893
268	215579	215692	215805	215918	216031
269	216708	216821	216934	217047	217160
270	217838	217951	218064	218177	218290
271	218969	219082	219195	219309	219422
272	220101	220215	220328	220442	220555
273	221235	221349	221462	221576	221689
274	222371	222484	222598	222711	222825
275	223507	223621	223734	223848	223962
276	224644	224754	224871	224986	225100
277	225784	225897	226011	226125	226239
278	226923	227038	227152	227266	227380
279	228065	228179	228294	228408	228522
280	229208	229322	229437	229551	229666
281	230352	230467	230581	230695	230810
282	231497	231612	231726	231841	231955
283	232644	232758	232873	232989	233103
284	233792	233906	234021	234136	234251
285	234946	235055	235170	235285	235400
286	236091	236206	236321	236436	236551
287	237242	237357	237472	237588	237703
288	238395	238510	238625	238740	238856
289	239548	239664	239779	239895	230010
290	240703	240819	240934	241050	241165
291	241859	241975	242090	242206	242322
292	243016	243132	243248	243364	243480
293	244175	244290	244406	244522	244638
294	245334	245450	245566	245682	245748
295	246495	246611	246727	246843	246959
296	247657	247773	247889	248006	248122
297	248820	248936	249053	249169	249285
298	249984	250101	250217	250334	250450
299	251149	251266	251382	251499	251615

5	6	7	8	9	
213891	214003	214115	214227	214340	112
214015	215128	215241	215354	215467	113
216143	216256	216369	216482	216595	113
217272	217386	217499	217612	217725	113
218403	218517	218630	218743	218856	113
219535	219648	219762	219875	219988	113
220668	220782	220895	221009	221122	113
221803	221916	222030	222143	222257	113
222538	223052	223166	223280	223393	114
224075	224189	224303	224417	224531	114
225214	225328	225442	225555	225670	114
226353	226467	226581	226695	226809	114
227494	227608	227723	227837	227951	114
228636	228751	228865	228979	229094	114
229780	229894	230009	230123	230238	114
230924	231039	231153	231268	231382	114
232070	232185	232299	232414	232529	115
233218	233332	233447	233562	233677	115
234366	234480	234595	234710	234825	115
235515	235630	235745	235860	235975	115
236666	236781	236896	237012	237127	115
237818	237933	238049	238164	238279	115
238971	239086	339202	239317	239433	115
240126	240241	240357	240472	240588	115
241281	241397	241522	241628	251753	116
242438	242553	242669	242785	242908	116
243595	243711	243827	243943	243059	116
244754	244870	244986	245102	245218	116
245915	246031	246147	246263	246379	116
247075	247192	247308	247424	247541	116
248238	248354	248471	248587	248704	116
249402	249518	249634	249751	249867	116
250567	250683	250799	250916	251033	117
251732	251849	251965	252082	252198	117

P

	0	1	2	3	4
300	252315	252432	252549	252665	252782
301	253483	253599	253716	253833	253950
302	254652	254769	254886	255003	255119
303	255822	255939	256056	256173	256289
304	256992	257109	257226	257344	257461
305	258164	258281	258398	258516	258633
306	259337	259454	259752	159689	259807
307	260511	260269	250746	260864	260981
308	261686	261803	251921	262039	262156
309	262862	262980	253097	263215	263332
310	264040	264157	264275	264393	264511
311	265218	265336	265454	265572	265690
312	266397	266515	266633	166751	266869
313	267578	267696	267814	267932	268050
314	268759	268877	268995	269113	269231
315	269941	270059	270177	270295	270413
316	271124	271242	271361	271479	271598
317	272309	272427	272546	272664	272783
318	273494	273612	273731	273849	273968
319	274680	274799	274917	275036	275155
320	275868	275986	276105	276224	276343
321	277056	277175	277294	277413	277532
322	278245	278364	278483	278602	278721
323	279436	279555	279674	279793	279912
324	280627	280746	280865	280985	281104
325	281819	281938	282058	282177	282296
326	283012	283131	283251	283370	283490
327	284207	284326	284446	288565	284685
328	285402	285521	285641	285760	285880
329	286598	286717	286837	286956	287076
330	287795	287915	288034	288154	288273
331	288992	289112	289232	289352	289472
332	280191	290311	290431	290551	290671
333	291391	291511	291631	291751	291871

5	6	7	8	9	
252899	253016	253132	253249	253366	117
254067	254184	254301	254418	254535	117
255237	255353	255471	255588	255701	117
256407	256524	256641	256758	256875	117
257573	257695	257812	257930	258047	117
258750	258867	258985	259102	259220	117
259924	259041	260159	260276	260394	117
261099	261216	261334	261451	261569	117
262274	262392	262509	262627	262744	117
263540	263568	263686	263804	263922	118
264269	264746	264864	264982	265100	118
265808	265925	266043	266161	266279	118
266987	267105	267223	267341	267459	118
268168	268286	268404	268522	268640	118
269349	269468	269586	269704	269823	118
270532	270650	270769	270887	271006	
271716	271835	271953	272072	272190	
272901	273020	273138	273257	273375	
274087	274205	274324	274443	274561	
275274	275392	275511	275630	275749	
276462	276580	276699	276818	276937	
277651	277769	277888	278007	278126	
278840	278959	279078	279197	279316	
280031	280150	280269	280389	280508	
281223	281342	281461	281581	281700	
282416	282535	282654	282773	282893	
283609	283729	283848	283968	284087	
284804	284924	285043	285163	285282	
286000	286119	286239	286358	286478	
287196	287315	287435	287555	287675	
288393	288513	288633	288752	288872	
289592	289711	289831	289951	290071	
290791	290911	291031	291151	291271	
291991	292111	292231	292351	292471	

	0	1	2	3	4
333	291391	291511	296331	291751	291871
334	292592	292712	292983	292952	293072
335	293793	293913	294033	294153	294273
336	294995	295115	295236	295356	295476
337	296198	296318	296779	296559	296680
338	297403	297523	297643	297764	297884
339	298608	298728	298849	298969	299090
340	299813	299934	300054	300175	300296
341	301020	301141	301281	301382	301503
342	302228	302348	302469	302590	302711
343	303436	303557	303678	303799	303920
344	304645	304766	304887	305008	305129
345	305856	305977	306098	306219	306340
346	307066	307187	307308	307430	307551
347	308278	308399	308520	308642	308763
348	309491	309612	309733	309854	309976
349	310704	310825	310947	311068	311190
350	311918	312040	312167	312283	312404
351	313133	313255	313376	313498	313619
352	314349	314471	314592	314714	314835
353	315566	315687	315890	315931	316052
354	316783	316905	312027	317148	317270
355	318001	318123	318245	318367	318489
356	319220	319342	319464	319586	319708
357	320440	320562	320684	320806	320928
358	321660	321782	321904	322026	322148
359	322881	323003	323125	323248	323370
360	324103	324225	324348	324470	324592
361	325326	325448	325571	325693	325815
362	326550	326672	326795	326917	327040
363	327773	327896	328018	328141	328263
364	328999	329125	329244	329366	329489
365	330224	330346	330469	330592	330714
366	331450	331572	331695	331818	331941

5	6	7	8	9	
291991	292111	292231	292351	292481	
293192	293312	293432	293552	293672	
294394	294514	294634	294754	294875	
295597	295717	295837	295957	296078	
296800	296021	297041	297162	297282	
298005	298125	298246	298366	298487	
299210	299331	299401	299572	299692	
300417	300537	300658	300779	300899	
301624	301744	301865	301986	302107	
302832	302952	303073	303194	303315	
304041	304161	304282	304043	304524	
305250	305371	305492	305613	305734	
306461	306582	306703	306824	306945	
307672	307192	307914	308036	308157	
308884	309005	309127	309248	309369	
310097	310219	310340	310461	310583	
311311	311432	311554	311675	311797	
312526	312647	312769	312890	313012	
313741	313863	313984	314106	314227	
314957	315079	315200	315322	315444	
316174	316296	316418	316539	316661	
317392	317514	317636	317757	317879	
318611	318732	318054	318976	319098	
319830	319952	320074	320196	320318	
321050	321172	321294	321416	321538	
322271	322393	322515	322637	322759	
323492	323614	323736	323859	323981	
324715	324837	324959	325081	325204	
325938	326060	326182	326305	326427	
327162	327284	327406	327529	327651	
328386	328509	328631	328754	328876	
329611	329734	329856	329979	330101	
330837	330960	331082	331205	331327	
332064	332186	332309	332432	332555	

	0	1	2	3	4
366	331450	331572	331695	331818	331941
367	332678	332800	332923	333046	333169
368	333905	334028	334151	334273	334396
369	335134	335256	335379	335502	335625
370	336313	336486	336609	336732	336855
371	337593	337716	337839	337962	338085
372	338823	338946	339069	339192	339315
373	340054	340177	340300	340423	340546
374	341286	341409	341532	341655	341779
375	342518	342641	342764	342888	343011
376	343752	343875	343998	344121	344245
377	344985	345108	345232	345355	345479
378	346220	346343	346467	346590	346714
379	347455	347578	347702	347825	347949
380	348691	348814	348938	349061	349185
381	349927	350050	350174	350298	350421
382	351164	351287	351411	851535	351659
383	352401	352525	352649	352772	352896
384	353640	353763	353887	354011	354135
385	354878	355002	355126	355250	355374
386	356118	356242	356366	356490	356614
387	357358	357482	357606	357730	357854
388	358598	358722	358846	358970	359094
389	359840	359964	360088	360212	360336
390	361081	361208	361329	361453	361578
391	362324	362448	362572	362698	362821
392	363567	363191	363815	363939	364064
393	364810	364934	365059	365183	365307
394	366054	366178	366303	396427	366552
395	367298	367422	367547	367672	367796
396	368544	368668	368793	369917	369042
397	369788	369912	370037	370162	370287
398	371036	371160	371285	371409	371534
399	372282	372407	372531	372656	372781

5	6	7	8	9
332064	332186	332309	332432	332555
333292	333414	333537	333660	333782
334519	334642	334765	334888	335011
335748	335871	335994	336117	336240
336978	337101	337224	337347	337470
338208	338331	338451	338577	338700
339438	339561	339684	339807	339930
340670	340793	340196	341039	341162
341902	342025	342148	342271	342394
343135	343258	343381	343505	343628
344368	344491	344615	344738	344862
345602	345726	345849	345973	346096
346837	347961	347082	347208	347331
348073	348916	348320	348443	348567
349309	349432	349556	349679	349803
350545	350669	350792	350916	351040
351783	351806	352030	352154	352277
353020	353144	353268	353392	353516
354259	354382	354506	354030	354754
355498	355622	355746	355870	355994
356738	356862	356986	357110	357234
357978	358102	358226	358350	358474
359219	359343	359467	359591	359715
360460	360584	360708	360832	360956
361702	361826	361951	362075	362199
362945	363069	363194	363318	363442
364188	364312	364437	364561	364686
365432	365556	315681	365805	365930
366676	366808	366925	367049	367173
367921	368046	368170	368295	368419
369166	369290	369415	369539	369663
370412	370537	370661	370786	370911
371659	371783	376908	372033	372157
372906	373030	373155	373280	373405

	0	1	2	3	4
400	373530	373654	373779	373904	374029
401	334778	374902	375027	375152	375277
402	376026	376150	376275	376400	376525
403	377275	377399	377524	377649	377774
404	378524	378649	378774	378899	379024
405	379774	379899	380024	380149	380274
406	381024	381149	381274	381399	381524
407	382275	382400	382525	382650	382775
408	333526	385651	383776	383902	384027
409	384778	384903	385028	385154	385279
410	386029	386155	386280	386406	386531
411	387283	387408	387533	387658	387784
412	388536	388661	388787	388912	389037
413	389790	389915	390040	390166	390291
414	391044	391169	391294	391420	391545
415	392298	392424	392549	392675	392800
416	393553	393679	393804	393930	394055
417	394809	394934	395060	395185	395311
418	396065	396190	396316	396441	396567
419	397321	397446	397572	397697	397823
420	398577	398703	398828	398954	349080
421	399834	399960	400085	400211	400337
422	401092	401217	401343	401469	401595
423	402349	402475	402601	402727	402853
424	403608	403733	403859	403985	404111
425	404866	404992	405118	405244	405370
426	406125	406251	406377	406503	406629
427	407385	407511	407637	407763	407889
428	408645	408771	408897	409023	409149
429	409405	410031	410157	410283	401409
430	411165	411291	411417	411543	411669
431	412426	412552	412678	412804	4 2930
432	413687	413813	413939	414065	414191
433	414948	415074	415207	415327	415453

5	6	7	8	9
374154	374278	374403	374528	374655
375402	375526	375651	375776	375901
376650	376775	376900	377025	377150
377899	378024	378149	378274	378399
379149	379274	379399	379524	379649
380399	380524	380649	380774	380899
381649	381774	381899	382024	382149
382901	383026	383151	383276	383401
384152	384277	384402	384528	384653
385404	385529	385654	385779	385904
386657	386782	386907	387032	387157
387909	388034	388160	388285	388421
389163	389288	389413	389539	389664
390417	390542	390667	390793	390918
391671	391796	391922	391047	392173
392926	393051	393177	393302	393428
394181	394306	394432	394557	394683
395437	397562	395688	395813	395939
396693	396818	396944	397069	397195
397949	398074	398200	398326	398451
399206	399331	399457	399583	399708
400463	400588	400714	400840	400966
401721	401846	401972	402098	402223
402979	403104	403230	403356	403482
404237	404362	404488	404614	404740
405496	405621	405747	405873	405999
406755	406881	407007	407133	407259
408015	408141	408267	408393	408519
409275	409401	409527	409653	409779
410535	410661	410787	410913	411039
411795	411921	412047	412173	412299
413056	413182	413308	413434	413560
414318	414444	414570	414696	414822
415579	415705	415831	415958	410084

	0	1	2	3	4
433	414948	415074	415200	415327	415453
434	416210	416336	416462	416589	416715
435	417473	417599	417725	417851	417977
436	418735	418861	418988	419114	419240
437	419998	420124	420251	420377	420503
438	421261	421387	421514	421640	421767
439	422525	422651	422778	422904	423030
440	423789	423915	424041	424168	424294
441	425053	425179	425306	425432	425559
442	426318	426444	426570	426697	426823
443	427582	427709	427853	427962	428088
444	428247	428974	429100	429227	429353
445	430113	430239	430366	430492	430619
446	431378	431505	431631	431758	431884
447	432644	432771	432897	433024	433050
448	433911	434037	434164	434290	434411
449	435177	435304	435430	435557	435683
450	436444	436570	436697	436824	436950
451	437717	437837	437964	438091	438217
452	438978	439105	439231	439358	439485
453	440246	440372	440499	440626	440752
454	441513	441640	441767	441893	442020
455	442781	442907	443034	443161	443288
456	444045	444172	444300	444428	444556
457	445318	445444	445571	445698	445825
458	446586	446713	446840	446967	447094
459	447854	447982	448089	448216	448343
460	449124	449251	449378	449505	449632
461	450394	450520	450647	450774	450801
462	451663	451790	451917	452044	452171
463	452933	453060	453187	453314	453441
464	454203	454330	454457	454584	454711
465	455473	455600	455727	455854	455981
466	456743	456870	456997	457124	457251

5	6	7	8	9
415579	415705	415831	415958	416084
416841	416967	417094	417220	417346
418104	418230	418356	418482	418609
419367	419493	419619	419745	419872
420630	420756	420882	421008	421135
421895	422019	422146	422272	422399
423157	423283	423409	423536	423662
424421	424547	424674	424800	424927
425685	425812	425938	425065	426191
426950	427076	427203	427329	427456
428215	428341	428468	428594	428721
429480	429607	429733	429860	429986
430746	430872	430999	431125	431252
432011	432138	432264	432391	432517
433277	433404	433530	433657	433784
434544	434670	434797	434924	435050
435810	435937	436063	436190	436317
437077	437204	437330	437457	437584
438344	438471	438598	438724	438851
439612	439738	439865	439990	440119
440879	441006	441133	441259	441386
442147	442274	442400	442527	442654
443415	443541	443667	443793	443929
444684	444810	444937	445064	445191
445952	446079	446206	446332	446459
447221	447347	447474	447601	447728
448490	448616	448743	448870	448997
449759	449886	450013	450140	450267
451028	451155	451282	451409	451536
452298	452425	452552	452679	452806
453568	453695	453822	453949	454076
454838	454965	455092	455219	455346
456108	456235	456362	456489	456616
457378	457505	457632	457759	457886

	0	1	2	3	4
466	456743	456870	456997	456124	457251
467	458013	458140	458267	458394	459521
468	459284	459411	459538	459665	459792
469	460554	460681	460808	460935	461062
470	461825	461952	462079	462206	462333
471	463096	463223	463350	463477	463604
472	464367	464494	464621	464749	464876
473	465639	465766	465893	466020	466147
474	466910	467037	467164	467291	467418
475	468182	468309	468437	468563	468690
476	469454	469581	469708	469835	469962
477	470725	470852	470979	471107	471234
478	471997	472124	472251	472379	472506
479	473269	473396	473523	473651	473778
480	474542	474669	474796	474923	475050
481	475614	475941	476068	476195	476322
482	477086	477213	477340	477468	477595
483	478359	478486	478613	478740	478867
484	479631	479758	479885	480013	480140
485	480940	481031	481158	481285	481413
486	482176	482303	482431	482558	482685
487	483449	483576	483704	483831	483958
488	484725	484849	484976	485104	485231
489	485992	486122	486249	486376	486504
490	487268	487395	487522	487649	487777
491	488541	488669	488795	488922	489050
492	489814	489931	490049	490166	490283
493	491087	491214	491342	491469	491596
494	492360	492487	492615	492742	492869
495	493633	493760	493888	494015	494143
496	494007	495034	495161	495288	495416
497	496180	496307	496434	496561	496689
498	497453	497580	497708	497835	497962
499	499726	498853	498981	499108	499235

5	6	7	8	9
457378	457505	457632	457759	457386
458648	458775	458902	459029	459156
459919	460046	460173	460300	460427
461190	461317	461444	461571	461698
462461	462588	462715	462842	462969
463732	463859	463986	464113	464240
465003	465130	465257	465384	465511
466274	466401	466528	466656	466783
467546	467673	467800	467927	468054
468818	468945	469072	469199	469326
470089	470216	470343	470471	470598
471361	471488	471615	471743	471870
472633	472760	472887	473015	473142
473905	474032	474160	474287	474414
475178	475305	475432	475559	475686
476450	476577	476704	476831	476959
477722	477849	477977	478104	478231
478995	479122	479249	479376	479504
480267	480394	480522	480649	480776
481540	481667	481794	481922	482049
482813	482940	483067	483194	483322
484086	484213	484340	484467	484595
485359	485486	485613	485740	485867
486631	486758	486886	487013	487140
487904	488031	488159	488286	488413
489177	489304	489432	489559	489687
490401	490538	490675	490812	490950
491724	491815	491978	492105	492233
492997	493124	493251	493378	493505
494270	494397	494525	494652	494779
495543	495670	495798	495925	496052
496816	496943	497071	497198	497327
498090	498217	498344	498471	498599
499363	499490	499616	499743	499871

FINIS.

Curious

James Burgess.

COSMOGRAPHIA,

THE

Second Part.

OR, THE

DOCTRINE

OF THE

PRIMUM MOBILE.

AN INTRODUCTION TO Aſtronomy.

The Firſt Part.

Of the *Primum Mobile*.

CHAP. I.

Of the General Subject of Aſtronomy.

ASTronomy, is a Science concerning the Meaſure and Motion of the Spheres and Stars.

2. Aſtronomy hath two parts, the firſt is Abſolute, and the other Comparative.

3. The Abſolute part of Aſtronomy is that which treateth of the Meaſure and Motion of the Orbs and Stars abſolutely without reſpect to any diſtinction of Time.

4. The Comparative part of Aſtronomy is that, which treateth of the Motion of the Stars, in reference to ſome certain diſtinction of Time.

5. The Abſolute part of Aſtronomy treateth of the *Primum Mobile*, or Diurnal Motion of all the Celeſtial Orbs or Spheres.

absurd

6. The *Primum Mobile*, or Diurnal Motion of the Heavens, is that Motion, by which the ſeveral Spheres are moved round the World in a Day and a Night, that is, in 24 hours from Eaſt towards Weſt, and ſo forward, from Weſt towards Eaſt, and ſo continually returning to the ſame point from whence they began their Motion.

7. This firſt and common Motion of the Heavens, will be beſt underſtood, by help of an Inſtrument called a Globe, which is an Artificial repreſentation of the Heavens, or the Earth and Waters under that Form and Figure of Roundneſs which they are ſuppoſed to have.

8. This Repreſentation or Deſcription of the Viſible World is by Circles, great and ſmall, ſome of which are expreſſed upon, and others are framed without the Globe.

9. The Circles without the Globe are chiefly two; the *Meridian* and the *Horizon*, the one of Braſs, and the other of Wood: And theſe two Circles are variable or mutable; for although there is but one *Horizon* and one *Meridian* in reſpect of the whole World, or in reſpect of the whole Heaven and Earth, yet in reſpect of the particular parts of Heaven, or rather in reſpect of the diverſe Provinces, Countries and Cities on the Earth, there are diverſe both *Horizons* and *Meridians*.

10.

10. The Meridian then is a great Circle without the Globe, dividing the Globe, and consequently the Day and Night into two equal parts, from the North and South ends whereof a strong Wyre of Brass or Iron is drawn or supposed to be drawn through the Center of the Globe representing the Axis of the Earth, by means whereof the whole Globe turneth round within the said Circle, so that any part may be brought directly under this Brass Meridian at pleasure.

11. This Brass Meridian is divided into 4 equal parts or Quadrants, and each of them are subdivided into 90 Degrees, that is 360 for the whole Circle. The reason why this Circle is not divided in 360 Degrees throughout, but still stoping at 90, beginneth again with 10.20.30 &c. is, for that the use of this Meridian, in reference to its Division in Degrees, requireth no more than that Number.

12. The Horizon is a great Circle without the Globe, which divides the upper part of Heaven from the lower, so that the one half is always above that Circle, and the other under it.

13. The Poles of this Circle are two, the one directly over our Heads, and is called the Zenith; the other is under feet, and is called the Nadir.

14. The Horizon is either Rational or Sensible.

15. The Rational Horizon is that, which divideth the Heavens and the Earth into two equal parts, which though it cannot be perceived and distinguished by the eye, yet may be conceived in our minds, in which respect all the Stars may be conceived to rise and set as in our view.

16. The Viſible Horizon is that Circle which the eye doth make at its fartheſt extent of ſight, when the body in any particular place doth turn it ſelf round. Of theſe two Circles there needeth no more to be ſaid at preſent, only we may obſerve, that it was ingeniouſly deviſed by thoſe, who firſt thought upon it, to ſet one Meridian and one Horizon without the Globe, to avoid the confuſion, if not the impoſſibility, of drawing a ſeveral Meridian and a ſeveral Horizon for every place, which muſt have been done if this or the like device had not been thought upon.

17. Beſides theſe two great Circles without the Globe, there are 4 other great Circles drawn upon the Globe it ſelf beſides the Meridian. 1. The Æquator or Equinoctial Circle. 2. The Zodiack. 3. The Æquinoctial Colure. 4. Solſtitial Colure. And theſe four Circles are immutable, that is, in whatſoever part of the World you are, theſe Circles have no variation, as the other two have.

18. The Æquator is a great Circle drawn upon the Globe, in the middle between the two Poles, and plainly dividing the Globe into two equal parts.

19. The Æquator is the meaſure of the Motion of the *Primum Mobile*, for 15 Degrees of this Circle do always ariſe in an hours time; the which doth clearly ſhew, that the whole Heavens are turned round by equal intervals in the ſpace of one day or 24 hours.

20. In this Circle the Declinations of the Stars are computed from the mid-Heaven towards the North or South.

21. This Circle gives denomination to the Æquinox, for the Sun doth twice in a Year and no more croſs this Circle, to wit, when he enters the firſt points of *Aries*, and *Libra*, and then he maketh the Days and the Nights equal: His entrance into *Aries* is in *March*, and is called the Vernal Equinox; and his entrance into Libra, is in *September*, and is called the Autumnal Equinox.

22. And from one certain point in this Circle, the Longitude of Places upon the Earth are reckoned; and the Latitude of Places are reckoned from this Circle towards the North, or the South Poles. Equato

23. The Zodiack is a great Circle drawn upon the Globe, cutting the Æquinoctial Points at Oblique Angles: for although it divides the whole World into two equal parts, in reference to its own Poles; yet in reference to the Poles of the World, it hath an Oblique Motion.

24. The Poles of this Circle are as far diſtant from the Poles of the World, as the greateſt Obliquity thereof is from the Equinoctial, that is 23 Degrees, and 31 Minutes or thereabouts. 27

25. This Circle doth differ from all other Circles upon the Globe in this: other Circles (to ſpeak properly) have Longitude aſſigned them, but no Latitude; but this hath both. Whereas other Circles are in reference to their Longitude or Rotundity only divided into 360 Degrees, this Circle in reſpect of its Latitude is ſuppoſed to be divided into 16 Degrees in Latitude.

26. The Zodiack then in reſpect of Longitude is commonly divided into 360 Degrees as o-

ther Circles are: but more peculiarly in respect of its self it is divided into 12 Parts called Signs, and each Sign into 30 Degrees, and 12 times 30 make 360.

27. The 12 Signs into which the Zodiack is divided, have these Names and Characters. *Aries* ♈. *Taurus* ♉. *Gemini* ♊. *Cancer* ♋. *Leo* ♌. *Virgo*
a ♍. *Libra* ♎. *Scorpio* ♏. *Sagittarius* ♐. *Capricornus* ♑. *Aquarius* ♒. and *Pisces* ♓.

28. These two Circles of the Equator and Zodiack are crossed by two other great Circles, which are called Colures: They are drawn through the Poles of the World, and cut one another as well as the Equator at Right Angles. One of them passeth through the Intersections of the Equinoctial points, and is called the Equinoctial Colure. The other passeth through the points of the greatest distance of the Zodiack, from the Equator, and is called the Solstitial Colure.

29. The other great Circles described upon the Globe are the Meridians: Where we must not think much to hear of the Meridians again. That of Brass without the Globe is to serve all turns, and the Globe is framed to apply it self thereto. The Meridians upon the Globe, will easily be perceived to be of a new and another use.

30. The Meridians upon the Globe are either the great or the less: Not that the great are any greater than the less, for they have all one and the same center, and equally pass through the Poles of the Earth; But those which are called less, are of less use than that, which is called the great.

31. The great is otherwise called the fixt and first Meridian, to which the less are second, and respectively moveable. The great Meridian is as it were the *Landmark* of the whole Sphere, from whence the Longitude of the Earth, or any part thereof is accounted. And it is the only Circle which passing through the Poles is graduated or divided into Degrees, not the whole Circle but the half, because the Longitude is to be reckoned round about the Earth.

32. The lesser Meridians are those black lines, which you see to pass through the Poles and succeeding the great at 10 and 10 Degrees, as in most Globes; or at 15 and 15 Degrees difference, as in some. Every place never so little more East or West than another, hath properly a several Meridian, yet because of the huge distance of the Earth from the Heavens, there is no sensible difference between the Meridians of places that are less than one Degree of Longitude asunder, and therefore the Geographers as well as the Astronomers allow a new Meridian to every Degree of the Equator; which would be 180 in all: but except the Globes were made of an extream and an unusual Diameter, so many would stand too thick for the Description. Therefore most commonly they put down but 18, that is, at 10 Degrees distance from one another; the special use of the lesser Meridians being to make a quicker dispatch, in the account of the Longitudes. Others set down but 12, at 15 Degrees difference; aiming at this, That the Meridians might be distant from one another a full part of time, or an hour: for seeing that the Sun is carried 15 Degrees of the Equinoctial every hour, the Meridians set at that

distance must make an hours difference in the rising or setting of the Sun in those places which differ 15 Degrees in Longitude.

And to this purpose also upon the North end of the Globe, without the Brass Meridian, there is a small Circle of Brass set, and divided into two equal parts, and each of them into twelve, that is, twenty four all; to shew the hour of the Day and Night, in any place where the Day and Night exceed not 24 hours; for which purpose it hath a little Brass Pin turning about upon the Pole, and pointing to the several hours, which is therefore the *Index Horarius*, or Hour *Index*.

33. Having described the great Circles framed without and drawn upon the Globe, we will now describe the lesser Circles also; And these lesser Circles are called Parallels, that is, such as are in all places equally distant from the Equator; and these Circles how little soever, are supposed to be divided into 360 Degrees: but these Degrees are not so large as in the great Circles, but do proportionably decrease according to the *Radius* by which they are drawn.

34. These lesser Circles are either the Tropicks or the Polar Circles.

35. The Tropicks are two small Circles drawn upon the Globe, one beyond the Equator towards the North Pole, and the other towards the South, Shewing the way which the Sun makes in his Diurnal Motion, when he is at his greatest distance from the Equator either North or South. These Circles are called Tropicks ἀπὸ τῆς τροπῆς, that is, from the Suns returning: for the Sun coming to these Circles, he is at his greatest distance from the Equator, and in the same Moment of time

sloping

ſloping as it were his courſe, he returns nearer and nearer to the Equator again.

36. Theſe Tropical Circles do ſhew the point of Heaven in which the Sun doth make either the longeſt Day, or the Shorteſt Day in the Year, according as he is in the Northern or the Southern Tropick: And are drawn at 23 Degrees and a half diſtant from the Equator.

37. The Polar Circles are two leſſer Circles drawn upon the Globe at the Radius of 23 Degrees and a half diſtant from the Poles of the World, ſhewing thereby the Poles of the Zodiack, which is ſo many Degrees diſtant from the Equator on both ſides thereof.

38. Theſe Polar Circles are 66 Degrees and a half diſtant from the Equator, and 43 Degrees diſtant from his neareſt Tropick. They are called the Arctick and Antarctick Circles.

39. The Arctick Circle is that which is deſcribed about the Arctick Pole, and paſſeth almoſt through the middle of the Head of the greater Bear. It is called the Arctick Circle ἀπὸ τῶν ἄρκτων· from the two conſpicuous Stars towards the North, called the greater and the leſſer Bear.

40. The Antarctick Circle is that which is deſcribed about the Antarctick or South Pole. It is ſo called ἀντὶ τῆς ἄρκτου that is, from being oppoſite to the greater and leſſer Bear.

Having thus deſcribed the Globe or Aſtronomical Inſtrument by which the Frame of the World is repreſented to our view, I will proceed to ſhew the uſe for which it is intended.

CHAP.

CHAP. II.

Of the Diſtinctions and Affections of Spherical Lines or Arches.

THE uſes of the Globe as to practice, are either ſuch as concern the Heavens or the Earth, in either of which, if we ſhould deſcend unto particulars, the uſes would be more in number, than a ſhort Treatiſe will contain: Seeing therefore that all Problems which concern the Globe, may be beſt and moſt accurately reſolved by the Doctrine of Spherical Triangles, we will contract theſe uſes of the Globe (which otherwiſe might prove infinite) to ſuch Problems as come within the compaſs of the 28 Caſes of Right and Oblique angled Spherical Triangles.

2. And that the nature of Spherical Triangles may be the better underſtood, and by which of the 28 Caſes the particular Problems may be beſt reſolved, I will ſet down ſome General Definitions and Affections, which do belong to ſuch Lines or Arches of which the Triangle muſt be framed, with the Parts and Affections of thoſe Triangles, and how the things given and required in them, may be repreſented and reſolved upon and by the Globe, as alſo how they may be repreſented and reſolved by the Projection of the Sphere, and by the Canon of Triangles.

3. A Spherical Triangle then is a Figure conſiſting of three Arches of the greateſt Circles upon the Superficies of a Sphere or Globe, every one being leſs than a ſemicircle.

4. A great Circle is that which divideth the Sphere or Globe into two equal parts, and thus the Horizon, Equator, Zodiack and Meridians before described are all of them great Circles: And of these Circles or any other, there must be three Arches to make a Triangle, and every one of these Arches severally must be less than a semicircle: To make this plain.

In *Fig.* 1. The streight Line *HAR* doth represent the Horizon, *PR* the height of the Pole above the Horizon, *PMS* a Meridian, and these three Arches by their intersecting one another do visibly constitute four Spherical Triangles, 1. *PMR.* 2. *PMH.* 3. *SHM.* 4. *SMR.* And every Arch is less than a semicircle, as in the Triangle *PMR*, the Arch *PR* is less than the Semicircle *PRS*, the Arch *MR* is less than the Semicircle *AMR*, and the Arch *PM* is less than the Semicircle *PMS*, the like may be shewed in the other Triangles.

5. Spherical or circular Lines are Parallel or Angular.

6. Parallel Arches or Circles, are such as are drawn upon the same Center within, without, or equal to another Arch or Circle. Thus in *Fig.* 1. The Arches ♋ *M* ♋ and ♑ *6* ♑ are though lesser Circles, parallel to the Equinoctial Æ *AQ* and do in that Scheme represent the Tropicks of Cancer and Capricorn. The manner of describing them or any other Parallel Circle is thus, set off their distance from the great Circle, to which you are to draw a parallel with your Compasses, by help of your Line of Chords, which in this Example is 23 Degrees and a half from Æ to ♋, then draw the Line *A* ♋, and upon the point ♋ erect a Perpendi-

pendicular, where that Perpendicular ſhall cut the Axis *P A S* extended, is the Center of that Parallel.

7. A Spherical Angle, is that which is conteined by two Arches of the greateſt Circles upon the Superficies of the Globe interſecting one another: Angles made by the Interſection of two little Circles, or of a little Circle with a great, we take no notice of in the Doctrine of Spherical Triangles.

8. A Spherical Angle is either Right or Oblique.

9. A Spherical Right Angle is that which is conteined, by two Arches of the greateſt Circles in the Superficies of the Sphere cutting one another at Right Angles, that is, the one being right or perpendicular to the other: thus the Braſs Meridian cutteth the Horizon at right Angles; and thus the Meridians drawn upon the Globe, as well as the Braſs Meridian, do all of them cut the Equator at Right Angles.

10. An Oblique Spherical Angle, is that which is conteined by two Arches of the greateſt Circles in the Superficies of the Sphere, not being right or perpendicular to one another.

11. An Oblique Spherical Angle is Obtuſe, or Acute.

12. An Obtuſe Spherical Angle, is that which is greater than a Right Angle. An Acute is that which is leſs than a Right Angle.

13. If two of the greateſt Circles of the Sphere ſhall paſs through one anothers Poles, thoſe two great Circles ſhall cut one another at Right Angles: Thus the Brazen Meridian doth interſect the Equinoctial and Horizon.

14.

14. If two of the greatest Circles of the Sphere shall intersect one another, and pass through each others Poles, they shall intersect one another at unequal or Oblique Angles, the Angle upon the one side of the intersection being Obtuse, or more than a Right, and the Angle upon the other side of the intersection being Acute or less than a Right. Thus in *Fig.*1. The Arch *P M* doth intersect the Meridian and Horizon, but not in the Poles of either, therefore the Angle *HPM* upon one side of the intersection of that Arch with the Meridian, is more than a Right Angle; And the Angle *MP R* upon the other side of the Intersection is less. And so likewise the Angle *P MH* upon the one side of the intersection of the Arch *P M* with the Horizon *H R*, is greater than a right Angle; and the Angle *R MP* upon the other side of the Intersection is less than a Right.

15. A Spherical Angle is measured by the Arch of a great Circle described from the Angular point between the sides of the Angle, those sides being continued unto Quadrants. Thus the Arch of the Equator *T Q* in *Fig.* 1. is the measure of the Angle *MP R*, or *T P Q*, the sides *P T* and *P Q* being Quadrants.

And the measure thereof in the Projection may thus be found: lay a Ruler from *P* to *T*, and it will cut the Primitive Circle in *V*; and the Arch *V Q* being taken in your Compasses and applyed to your Line of Chords, will give the Quantity of the Angle propounded.

16. The Complement of a Spherical Arch or Angle, is so much as it wanteth of a Quadrant, if the Arch or Angle given be less than a Quadrant; or so much as it wanteth of a Semicircle,

cle, if it be more than a Quadrant.

17. An Arch of a great Circle cutting the Arch of another great Circle, shall intersect one another at Right Angles, or make two Angles, which being taken together, shall be equal unto two Right. Thus in *Fig.* 1. The Axis *PAS* or Equinoctial Colure doth cut the Equator *ÆAQ* at Right Angles, but the Meridian *PMS* doth cut the Horizon *HMR* at Oblique Angles, making the Angle *PMR* less than a Right, and the Angle *SMR* more than a Right, and both together equal to a Semicircle.

18. From these general Definitions proper to Spherical Lines or Arches, the general Affections of these Arches may easily be discerned; I mean the various Positions of the Globe of the Earth, in respect of all and singular the Inhabitants thereof.

19. And the whole Body of the Sphere or Globe, in respect of the Horizon, is looked upon by the Earths Inhabitants, either in a Parallel, a Right, or an Oblique Sphere.

20. A Parallel Sphere is, when one of the Poles of the World is elevated above the Horizon to the Zenith, the other depressed as low as the Nadir, and the Equinoctial Line joyned with the Horizon. They which there inhabite (if any such be) see not the Sun or other Star rising or setting, or higher or lower in their diurnal revolution. And seeing that the Sun traverseth the whole Zodiack in a Year, and that half the Zodiack, is above the Horizon and half under it, it cometh to pass, that the Sun setteth not with them, for the space of six Months, nor giveth them any Light for the space of other six Months, and so

maketh

maketh but one Day and Night of the whole Year.

21. A Right Sphear is, when both the Poles of the World do lie in the Horizon, and the Equinoctial Circle is at his greatest distance from it, passing through the Zenith of the place. And in this position of the Sphere, all the Cœlestial Bodies, Sun, Moon, and other Planets, and fixed Stars, by the daily turning about of the Heaven, do directly ascend above, and also directly descend below the Horizon, because the Motions which they make in their Daily motion do cut the Horizon Perpendicularly, and as it were at Right Angles. In this Position of the Sphere, all the Stars may be observed to rise and set in an equal space of time, and to continue as long above the Horizon, as they do under it, the Day and Night to those Inhabitants, being always of an equal length.

22. An Oblique Sphere is, when the Axis of the World (being neither Direct nor Parallel to the Horizon) is inclined obliquely towards both sides of the Horizon, as in *Fig.* 1. Whence it cometh to pass, that so much as one of the Poles is elevated above the Horizon, upon the one side; so much is the other depressed under the Horizon, upon the other side.

And in this Position of Sphere, the Days are sometimes longer than the Nights, sometimes shorter, and sometimes of equal length: When the Sun is in either of the Equinoctial Points, the Days and Nights are equal; but when he declineth from the Equator towards the elevated Pole, the Days are observed to encrease; and when he declineth from the Equator towards the opposite Pole, or the Pole depressed,

depressed, the Days do decrease, as is manifest in *Fig.* 1. For when the Sun riseth at *M*, the Line *M* ♋ above the Horizon is the Semidiurnal Arch of the longest day. When he riseth at *C*, the Arch *C* ♑ above the Horizon, is the Semidiurnal Arch of the shortest Day : And when he riseth at *A*, the Days and Nights are of equal Length, the Semidiurnal Arch *A Æ*, being equal to the Seminocturnal Arch *AQ*.

CHAP. III.

Of the kind and parts of Spherical Triangles; and how to project the same upon the Plane of the Meridian.

HAving shewed what a Spherical Triangle is, and of what Circles it is composed, with the general Affections of such Lines : I will now shew how many several sorts of Triangles there are, of what Circular parts they do consist, and such Affections proper to them as will render the solution of them more clear and certain.

2. Spherical Triangles are either Right or Oblique.

3. A Right Angled Spherical Triangle, is that which hath one or more Right Angles.

4. A Spherical Triangle which hath three Right Angles, hath always his three sides Quadrants. As in *Fig.* 1. The Spherical Triangle *AZR*, the Angles *ZRA*, *RAZ* and *AZR* are right Angles, and the three sides *AZ*, *ZR* and *AR* are Quadrants also.

5. A

5. A Triangle that hath two right Angles, hath the sides opposite to those Angles Quadrants, and the third side is the measure of the third Angle. As in *Fig.* 1. The sides of the Spherical Triangle *TPQ*, namely *TP* and *PQ* are Quadrants, and the Angles opposite to these sides, to wit, *PTQ* and *TQP* are Quadrants also, and the third Angle *TQ* is the measure of the third Angle *TPQ*. But the Right Angled Triangle which hath one Right and two Acute Angles, is that which cometh most commonly to be resolved.

6. The Legs of a right Angled Spherical Triangle are of the same Affection with their opposite Angles; as in the Triangle *ZAR* *Fig.* 1. The side *ZA* is a Quadrant, and the Angle at *A* is right, because *Z* is the Pole of the Arch *AR* and *ZA* is perpendicular thereunto. And in the Triangle *RAÆ* the side *RZÆ* being more then a Quadrant the Angle *RAÆ* is more then a Quadrant also, being more then the Right Angle *RAZ*. And in the right Angled Spherical Triangle *APR* the side *PR* being less then a Quadrant, the Angle *PAR* is less then a Quadrant also, being less then the right Angle *RAZ*.

7. An Oblique angled Spherical Triangle is either acute or obtuse.

8. An Acute angled Spherical Triangle hath all his Angles Acute, and each Side less then a Quadrant; As in the Triangles, *ZFP*. *Fig.* 2. The Angles at *Z* and *P* are acute, as appeareth by inspection; and the Angle at *F* is acute also because the Measure thereof *CD* = *EM* is less then a Quadrant.

9. An Oblique Angled Spherical Triangle hath all his Angles either acute or obtuſe: *viz.* Acute and mixt.

10. The Sides of a Spherical Triangle may be turned into Angles, and the Angles into Sides; The Complement of the greateſt Side or greateſt Angle to a Semicircle being taken in each converſion. For Example. If it were required to turn the Angles of the Oblique Angled Spherical Triangle *Z F P* into ſides in *Fig.* 3. *E Æ* is the meaſure of the Angle at *P*, and *A D* in the Triangle *A D C* eqnal thereunto, *A C* is the Complement of *F Z P* to a Semicircle, and *K M* the the Meaſure of the Angle at *F* is equal to *D C*, and ſo the Sides of the Spherical Triangle *A D* C are equal to the Angles of the Spherical Triangle *F Z P*, making the ſide *AC* equal to the Complement of the Angle Z to a Semicircle.

11. In Right Angled Spherical Triangles the Sides intending the Right Angle we call the Legs; The Side ſubtending it the *Hypotenuſe*.

12. In every Spherical Triangle beſides the Area or ſpace contained, there are ſix parts. *viz.* Three Sides and three Angles and of theſe ſix there muſt be always three given to find the reſt, but in right Angled Spherical Triangles there are but five of the ſix parts parts which come into queſtion, becauſe one of the Angles being right is allways known, and ſo any two of the other five being given, the three remaining parts whether Sides or Angles, may be found. But before I come to the ſolution of theſe Triangles whether right or oblique, I will firſt ſhew how they may be repreſented upon the Globe, and projected upon the plane of of the Meridian.

13. A

13. A right Angled Spherical Triangle may be represented upon the Globe in this manner: Elevate one of the Poles of the Globe above the Horizon, to the quantity of one of the given Legs, so shall the distance between the Æquinox and the Zenith be equal thereunto, and at the Zenith fasten the Quadrant of altitude, so shall there be delineated upon the Globe the right Angled Spherical Triangle *Æ Z B* as may be seen in *Fig.* 1. In which the outward Circle *H Z R* doth represent the Brass Meridian, *Æ A Q* the Equator, and *Z C* the Quadrant of altitude.

14. An Oblique Angled Spherical Triangle may be represented upon the Globe in this manner. Number one of the given sides from one of the Poles to the Zenith; and there fasten the Quadrant of Altitude, upon which number another side, the third upon the great Meridian, from the Pole towards the Equinoctial, then turn the Globe till the Side numbred upon the Quadrant of Altitude, and the Side numbred upon the great Meridian shall intersect one another; so shall there be delineated upon the Globe the Oblique Angled Spherical Triangle *Z F P* in *Fig.* 3. In which *Z P* is numbred upon the Brass Meridian from *S* the Pole of the World to *Z* the Zenith, *Z F* the Azimuth Circle represents the Quadrant of Altitude, and *P F* the great Meridian upon the Globe intersecting the Quadrant of Altitude at *F*.

15. A Right or Oblique Angled Spherical Triangle being thus delineated upon the Globe, there needs no further instructions, as to the measure of the sides, all that is wanting, is the laying down the Angles comprehended by those sides, and the finding out the measure of these Angles

being ſo laid down. And that this may be the better underſtood, I will firſt ſhew; how the ſeveral Circles upon the Globe before deſcribed, may be projected upon the Plane of the Meridian, and the ſeveral uſeful Triangles that are deſcribed by ſuch Projection with ſuch Aſtronomical Propoſitions as are conteined and reſolvable by theſe Triangles.

16. The Circles in the firſt Figure are the Meridian, Æquator, Horizon, Æquinoctial Colure, and the Tropicks. The Braſs Meridian without the Globe, is a perfect Circle deſcribed by taking 60 Degrees from your Line of Chords, as the Circle *HZRN* in *Fig.* 1. Within which all the other are projected. The Horizon, Æquator, Æquinoctial Colure, Eaſt and Weſt Azimuths are all ſtreight Lines. Thus the Diameter *HAR* repreſents the Horizon, *Æ A Q* the Equator, *P A S* the Equinoctial Colure and *Z A N* the Eaſt and Weſt Azimuths, in the drawing of theſe there is no difficulty, *PMS* is a Meridian, and *ZCN* an Azimuth Circle, for the drawing of which there are three points given and the Centers of the Meridians do always fall in the Equinoctial extended if need be, the Centers of the Azimuth Circles do fall in the Horizon extended if need be, and for the drawing of theſe Circles there needs no further direction, ſuppoſing the middle point given to be in the Æquator or Horizon, but yet the Centers of theſe Circles may be readily found, by the Lines of Tangents or Secants, for the Tangent of the Complement of *AT* ſet from *A* to *D*, or the Secant of the Complement ſet from *A* to *D* will give the Center of the Meridian *PTS*. The other two Circles in the 1. *Fig.* are

are the Tropicks whose Centers are thus found; each Tropick is Deg. 23½ from the Equinoctial, which distance being set upon the Meridian from *Æ* to ♋ and *Æ* to ♑, if you draw a Line from *A* to ♋ and another perpendicular thereunto from ♋ it will cut the Axis *S A P* extended in the Center of that Tropick, by which extent of the compasses the other Tropick may be drawn also. Or thus the Co-tangent of *Æ* ♋ set from ♋ to the Axis extended will give the Center as before, and thus may all other Parallels be described.

17. In the second and third figures, the two extream points given in the Meridians are not equidistant from the third, for the drawing of which Circles, if the common way of bringing three points into a Circle be not liked; you may do thus, from the given point at *F* and the Center *A* draw the Diameter *T A S*, and cross the same at Right Angles with the Diameter *B A G*, a Ruler laid from *G* to *F* will cut the primitive Circle in *L*, make *EL* = *BL* a Ruler laid from *G* to *E* will cut the Diameter *S A T* in *V* the Center of the Circle *B D G*. Which Circle doth cut the Diameter *H A R* in the Pole of *Z F*, and the Diameter *Æ A Q* in *D* in the Pole of *P F X*, and a Ruler laid from *Z* to *C* will cut the Primitive Circle in *Y*, and making *Y O* equal to *Y* a Ruler laid from *Z* to *O* will cut the Diameter *H A R*, extended in the Center of the Circle *Z F*.

18. Having drawn the Circle *Z F I*, in *Fig.* 13. The Circle *P E X*, or any other passing through the point *F*, may easily be described. Draw *Æ Q* at right Angles to *P X*, a Ruler laid from *G* unto (*e*) will cut the Primitive Circle in (*m*) make *m n* = *B n*, a Ruler laid from *G* to *n*

shall cut the Diameter *TFS* in *p* make *Fq* = *Fp* so shall *FQ* be the Radius, and the Center of the Circle *PFX* as was desired.

19. The preceeding directions are sufficient for the projecting of several Circles of the Globe before described upon the Plane of the Meridian, and the parts of those Circles so described may thus be measured. In *Fig.*1. *HZ* = *CZ* = *AZ* 90 Degrees. Whence it followeth, that the Quadrant *CZ* is divided into Degrees from its Pole *M*, by the Degrees of the Quadrant *HZ*, that is a Ruler laid from *M* to any part of the Quadrant *HZ* will cut as many Degrees in *CZ* as it doth in the Quadrant *HZ*, and thus the Arch *CF* = *HK* the Arch *CB* = *HL*, and the Arch *BF* = *LK*.

20. That which is next to be considered is the projecting or laying down the Angles of a Triangle, and the measuring of them being projected, and the Angles of a Triangle are either such as are conteined between two right Lines as the Angle *A* in the Triangle *PAR*; or such as are conteined by a streight and a Circular Line, as the Angle *PMR*. *Fig.*1. Or such as are conteined by two circular Lines, as the Angles *FZP* or *ZFP* in *Fig.*3. The projecting or measuring the first sort of these Angles, needs no direction.

21. To project an Angle conteined by a streight and a circular line as the Angle *ÆBZ* in *Fig.*1. Do thus, lay a Ruler from *N* to *C*, and it will cut the Primitive Circle in *K* make *ZX* = *HK*, a Ruler laid from *N* to *X* will cut the Diameter *HAR* in the point *M* the Pole of the Circle *ZCN*, a Ruler laid from *M* to *B* the Angular point propounded, will cut the primitive Circle in *I*, make

NY

NY = *HL* a Ruler laid from *N* to *Y* will cut the Circle *ZCN* in *W*, a Ruler laid from *B* to *W* will cut the Primitive Circle in *A*, make *AQ* equal to the Angle propounded, and draw the Diameter *BAQ*, then is the Angle *ÆBZ* or *NBQ* = *NQ* as was required.

22. If the Angle had been projected and the measure required, a Ruler laid from *M* to *B* would give *L* and making *NY* = *HL* a Ruler laid from *M* to *Y* would give *W*, from *B* to *W* would give *A*, and *AQ* would be the measure of the Angle propounded.

23. To project an Angle conteined by two circular lines, one of them being an Arch of the Primitive Circle, as the Angle *ÆZB*, *Fig.* 1. Do thus, set off the quantity of the Angle given from *H* to *G*, a Ruler laid from *Z* to *G* will cut the Diameter *HAR* in the point *C*, so may you draw the Circle *ZCN* and the Angle *HZC* will be equal to the Arch *HG* = *HC* as was required.

24. If the Angle had been projected and the measure required, a Ruler laid from *Z* to *C* would cut the Primitive Circle in *G* and *HG* would be the measure of the Angle propounded.

25. To project an Angle conteined by two oblique Arches of a Circle, as the Angle *ZFP* in *Fig.* 3. You must first find the Pole of one of the two Circles conteining the Angle propounded, suppose *ZBI*, a Ruler laid from *C* the Pole thereof to *F*, the Angular point propounded, will cut the Primitive Circle in *a* make *ab* equal to the Angle propounded, a Ruler laid from *F* to *b* will cut the Diameter *ÆAQ* in *D* the Pole of the Circle *PEX*, a Ruler laid from *G* to *e* will cut the Primitive Circle in *m*, make *mn* = *Bm* a Ru-

ler laid from G to n will cut the Diameter TAS in p, make $Aq = Ap$ so shall Fp be the Radius and the Center of the Circle PFX and the Angle $ZFP = ab$, as was propounded.

26. If the Angle had been projected and the measure required; through the point F draw the Diameter TFS and the Diameter BAG at right Angles thereunto, a Ruler laid from G to F will cut the Primitive Circle in K, and making $KE = BK$ a Line drawn from G to E will cut the Diameter TAS in the Center of the Circle GDB cutting the Diameter HAR in C the Pole of the Circle ZBI, and the Diameter $ÆAQ$ in D, the Pole of the Circle PEX and a Ruler laid from F to C and D will cut the Primitive Circle in a and b the measure of the Angle required.

Or a Ruler laid from F to K and M will cut the Primitive Circle in Deg. the measure of the Angle propounded as before.

Or thus a Ruler laid from C and D to F will cut the Primitive Circle in a and b set 90 Degrees from e and b to f and l a Ruler laid from C to f will cut ZBI in M and a Ruler laid from D to l will cut PEX in K. This done a Ruler laid from F to K and M will cut the Primitive Circle in g and d the measure of the Angle as before.

And in *Fig.*2. The quantity of the Angle ZFP may thus be found. A Ruler laid from C the Pole of the Circle ZFI to F the angular point will cut the Primitive Circle in a, set off a Quadrant from a to b, a Ruler laid from C to b will cut the Circle ZFI in the point M. In like manner a Ruler laid from D the Pole of the Circle PEX, will cut the Primitive Circle in D, set off a Quadrant from A to h, a Ruler laid from D to P will

cut

cut the Circle *P F X* in *K*: Lastly a Ruler laid from *F* to *K*, and *M* will cut the Primitive Circle in *N S* the measure of the Angle *K F M* or *Z F P*, as was propounded.

27. Having shewed how a right or oblique Angled Spherical Triangle may be projected upon the Plane of the Meridian, as well as delineated upon the Globe, we will now consider the several Triangles usually represented upon the Globe, with the several Astronomical and Geographical Problems conteined in them, and resolved by them.

28. The Spherical Triangles usually represented upon the Globe are eight, whereof there are five Right angled Triangles, have their Denomination from their *Hypotenusas*.

The first is called the Ecliptical Triangle, whose *Hypotenusa* is an Arch of the Ecliptick, the Legs thereof are Arches of the Æquator and Meridian, this is represented upon the Globe, by the Triangle *A D F*, in *Fig.* 1. In which the five Circular parts, besides the Right Angle are;

1. The *Hypotenuse* or Arch of the Ecliptick *A F*.

2. The Leg or Arch of the Æquator, *A D*.

3. The Leg or Arch of the Meridian *D F*.

4. The Oblique Angle of the Æquator with the Ecliptick and the Suns greatest Declination *D A F*.

5. The Oblique Angle of the Ecliptick and Meridian, or the Angle of the Suns position *A F D*.

The two next I call Meridional, because the *Hypotenusas* in them both, are Arches of a Meridian. One of these is noted with the Letters

M P R

M P R in *Fig.* 1. In which the five Circular parts are;

1. The *Hypotenusa* or Arch of a Meridian *P M.*

2. The Leg or Arch of the Horizon *M R*, the Suns Azimuth North.

3. The Leg or Arch of the Brass Meridian, representing the height of the Pole *P R.*

4. The Oblique Angle of the Meridian upon the Globe, with the Brass Meridian, or Angle of the Hour from Midnight. *P.*

5. The Oblique Angle of the Suns Meridian with the Horizon, or the Complement of the Suns Angle of Position *P M R.*

The other Right Angled Meridional Triangle is noted with the Letters *A E G* in *Fig.* 1. In which the 5 Circular parts are.

1. The *Hypotenusa* or present Declination of the Sun, *A E.*

2. The Leg or Suns Amplitude at the hour of six, *A G.*

3. The other Leg or Suns height at the same time *E G.*

4. The Angle of the Meridian with the Horizon, or Angle of the Poles elevation, *E A G.*

5. The Angle of the Meridian with the Azimuth, or the Angle of the Suns position, *A E G.*

The fourth Right Angled Spherical Triangle, I call an Azimuth Triangle, because the *Hypotenusa* doth cut the Horizon in the East and West Azimuths, as is represented by the Triangle *ADV*, in *Fig.* 1. In which the 5 Circular parts are,

1. The

1. The *Hypotenusa*, or Arch of the Sun or Stars Altitude *AV*.

2. The Leg or Declination of the Sun or Star, *DV*.

3. The other Leg, or Right Ascension of the Sun or Star, *AD*.

4. The Oblique Angle or Angle of the Poles elevation, *DAV*.

5. The other Oblique Angle or Angle of the Sun or Stars Position, *DVA*.

The fifth and last Right Angled Spherical Triangle, that I shall mention, I call an Horizontal Triangle, because the *Hypotenusa* thereof is an Arch of the Horizon, and is represented by the Triangle *AMT* in *Fig.* 1. In which the 5 Circular parts are;

1. The *Hypotenusa* and Arch of the Horizon, or Amplitude of the Sun at his rising or setting, *AM*.

2. The Leg conteining the Sun or Stars Declination *TM*.

3. The other Leg or Ascensional difference *AT*, that is, the difference between *DT* the Right Ascension and *DA* the Oblique Angle.

4. The Oblique Angle of the Horizon and Equator, or height of the Equator *TAM*.

5. The other Oblique Angle, or Angle of the Horizon and Meridian *AMT*.

The Oblique Angled Spherical Triangles usually represented upon the Globe are three. The first I call the Complemental Triangle, because the sides thereof are all Complements, and this is represented by the Triangle *FZP* in *Fig.* 1. Whose Circular parts are;

1. The Complement of the Poles elevation *ZP*.

2. The

2. The Complement of the Suns Declination, *FP*.

3. The Complement of the Suns Altitude or Almicantar *F Z*.

4. The Suns Azimuth or Diſtance from the North *F Z P*.

5. The hour of the day or diſtance of the Sun from Noon *Z P F*.

6. The Angle of the Suns Poſition *Z F P*.

The ſecond Oblique Angled Spherical Triangle, I call a Geographical or Nautical Triangle, becauſe it ſerveth to reſolve thoſe Problems, which concern Geographie and Navigation, and this is alſo repreſented by the Triangle *F Z P* in *Fig*. 1. Whoſe parts are.

1. The Complement of Latitude as before *Z P*.

2. The diſtance between the two places at *Z* and *F* or ſide *F Z*.

3. The Complement of the Latitude of the place at *F* or ſide *F P*.

4. The difference of Longitude between the two places at *Z* and *F* or the Angle *F B Z*.

5. The point of the compaſs leading from *Z* to *F* or Angle *F Z P*.

6. The point of the Compaſs leading from *F* to *Z*, or Angle *Z F P*.

The third Oblique Angled Spherical Triangle is called a Polar Triangle, becauſe one ſide thereof is the diſtance between the Poles of the World, and the Poles of the Zodiack. This Triangle is repreſented upon the Cœleſtial Globe, by the Triangle *F S P* in *Fig*. 4. In which the Circular parts are;

1. The diſtance between the Pole of the World,

World, and the Pole of the Ecliptick, or the Arch *S P*.

2. The Complement of the Stars Declination, *F P*.

3. The Complement of the Stars North Latitude, from the Ecliptick or the Arch *F S*.

4. The Angle of the Stars Right Aſcenſion *F P S*.

5. The Complement of the Stars Longitude *F S P*.

6. The Angle of the Stars Poſition *S F P*.

29. And thus at length I have performed, what was propoſed in the 15 of this Chapter, that is, I have ſhewed how the ſeveral Circles of the Globe, may be projected upon the Plane of the Meridian, the ſeveral uſeful Triangles that are deſcribed by ſuch projection, with ſuch Aſtronomical Propoſitions as are contained and reſolveable by thoſe Triangles; And although the moſt accurate way of reſolution is by the Doctrine of Trigonometry and the Canon of Lines and Tangents, yet it is not impertinent to do the ſame upon the Globe it ſelf, which as to the ſides is eaſie, but to meaſure or lay down the Angles is ſometimes a little labourious.

In the Right Angled Spherical Triangle *ÆBZ* in *Fig.*1. The meaſure of the Angle *ÆZB* is reckoned in the Horizon from *H* to *C* but to lay down or meaſure the Angle *ÆBZ* the readieſt way is to deſcribe the Triangle again, making *ÆZ* = *ÆB* and *ÆB* = *ÆZ*, ſo will the Angle *ÆBZ* ſtand where the Angle *ÆZB* is, and may be meaſured in the Horizon as the other was.

And so in the Oblique Angled Spherical Triangle *F Z P* in *Fig.* 1. The Angles at *Z* and *P* are easily measured or laid down upon the Globe, but to perform the same with the Angle *Z F P*, you may represent it at the Pole or Zenith and find the measure in the Equator or Horizon.

30. And now having, as I hope, sufficiently prepared the young Student for the first part of Astronomy, the Doctrine of the *Primum Mobile*, by shewing how the Heavens and the Earth are represented upon the Globe, or may be projected in Plane, I will now proceed to such Astronomical Propositions as are generally useful, and may be sufficient for an Introduction to this noble Science: to go through the several Triangles before propounded, will be very tedious, I will therefore shew the several Problems in one Right Angled and one Oblique Angled Spherical Triangle and the Canons by which they are to be resolved, and leave the rest for the Practice of my Reader. To this purpose I will next acquaint you with my Lord *Nepiers* Catholick Proposition for the solution of all Right and Oblique Angled Spherical Triangles.

CHAP.

CHAP. IV.

Of the solution of Spherical Triangles.

IN Spherical Triangles there are 28 Varieties or Cases, 16 in Rectangular, and 12 in Oblique, whereof all the Rectangular and ten of the Oblique may be resolved by the two Axioms following.

1. *Axiom.* In all Right Angled Spherical Triangles having the same Acute Angle at the Base, the Sines of the *Hypotenusas* are proportional to the Sines of their Perpendicular.

2. *Axiom.* In all right Angled Spherical Triangles, the Sines of the Bases and the Tangents of the Perpendicular are proportional.

That all the Cases of a Right Angled Spherical Triangle may be resolved by these two Axioms, the several parts of the Spherical Triangle proposed, that so the Angles may be turned into sides, the *Hypotenusa*, into Bases and Perpendiculars and the contrary. By which means the proportions as to the parts of the Triangle given, are sometimes changed into Co-sines instead of Sines, and into Co-tangents instead of Tangents. Which the Lord *Nepier* observing; those parts of the Right Angled Spherical Triangle, which in conversion do change their proportion, he noteth by their Complements. *viz.* The *Hypotenuse* and the two Acute Angles: But the sides or Legs are not so noted,

ted, as in the Right Angled Spherical Triangle *MPR* in *Fig.* 1. And these five he calleth the Circular parts of the Triangle, amongst which the Right Angle is not reckoned.

2. Now if you reckon five Circulat parts in a Triangle, one of them must needs be in the middle, and of the other four, two are adjacent to that middle part, the other two are disjunct, and which soever of the five you call the middle part, for every one of them may by supposition be made so; those two Circular parts which are on each side of the middle are called extreams adjunct, and the other two remaining parts, are called extream disjunct, as in the Triangle *MPR* if you make the Leg *PR* the middle part, then the other Leg *MR* and the Angle Comp. *P*. Are the extreams conjunct, the Hyp. Comp. *MP* and Comp. *M*, are the extreams disjunct, and so of the rest, as in the following Table.

opposite

Mid.

Mid. part	Extr. conj.	Extr. disj-
Leg *PR*	Leg. *MR* Comp. *P*	Comp. *M* Comp. *MP*
Leg *MR*	Leg. *PR* Comp. *M*	Comp. *MP* Comp. *P*
Comp. *M*	Leg. *MR* Comp. *MP*	Comp. *P* Leg. *PR*
Comp. *MP*	Comp. *M* Comp. *P*.	Leg. *PR* Leg. *MR*
Comp. *P*	Comp. *MP* Leg. *PR*	Leg. *MR* Comp. *M*

3. These things premised, the Ld. *Nepier* as a consectory from the two preceeding Axioms hath composed this Catholick and Universal Proposition.

The Rectangle under ~~*made*~~ *of the Sine of the middle part and* Radius *is equal to the Rectangle* under ~~*made*~~ *of the Tangents of the Extremes conjunct or the cosines of the Extremes disjunct.*

Therefore if the middle part be sought, the *Radius* must be in the first place; if either of the extremes, the other extreme must be in the first place.

Only note that if the middle part, or either of the extremes propounded be noted with its

S Comp.

Comp. in the circular parts of the Triangle, instead of the Sine or Tangent you must use the Cosine or Cotangent of such circular part or parts.

That these directions may be the better conceived, we have in the Table following set down the circular parts of a Triangle under their respective Titles, whether they be taken for the middle part, or for the extremes, conjunct or disjunct, and unto these parts, we have prefixed the Sine or Cosine, the Tangent or Cotangent, as it ought to be by the former Rule.

Mid. Par.	Extr. Conj.	Ext. Disj.
Sine *P R*	Tang. *M R* Tang. *P.*	Sine *M* Sine *M P*
Sine *M R*	Tang. *P R* Cotang. *M.*	Sine *M P* Sine *P*
Cosine *M*	Tang. *M R* Cot. *M P*	Sine *P* Cos. *P R*
Cos. *M P*	Cotang. *M.* Cotang. *P*	Cos. *P R* Cos. *M R*
Cosine *P*	Cot. *M P* Tang. *P R*	Cos. *M R* Sine *M*

Now

Now then according to this Table and the former Rules.

1. Sine PR x Rad. = t MR x ct P.
2. Sine PR x Rad. = s M x s MP.
3. Sine MR x Rad. = t PR x ct M.
4. Sine MR x Rad. = s MP x s P.
5. Cos. M x Rad. = t MR x ct MP.
6. Cos. M x Rad. = s P x cs PR.
7. Cos. MP x Rad. = ct M x ct P.
8. Cos. MP x Rad. = cos. PR x cs MR.
9. Cos. P x Rad. = ct MP x t PR.
10. Cos. P x Rad. = cos. MR x s M.

By these 10 Rectangles may the 16 Cases of a Right angled Spherical Triangle be resolved, and some of them twice over; for although there are but 16 varieties in all Right angled Spherical Triangles, yet 30 Astronomical Problems may be resolved by one Triangle, as by the following Examples shall more clearly appear.

Of Right angled Spherical Triangles.

CASE 1.

The Legs given, to find the Angles.

IN the Right angled Spherical Triangle *MPR*. The given Legs are *MR* and *RP*. The Angles at *M* and *P* are required.

By the first of the 10 equal Rectangles s *PR* x Rad. = t *MR* x ct *P*. in which *P* is sought, therefore putting *MR* in the first place. The proportion is. t *MR*. Rad. : : s *PR*. ct *P*.

And by the third equal Rectangle. t *PR*. Rad. : : s *MR*. ct *M*.

CASE 2.

The Legs given, to find the Hypotenuse.

In the Right angled Spherical Triangle *MPR*. The given Legs are *MR* and *PR*. The Hypotenuse *MP* is required.

By the eighth of the 10 Rectangles cos. *MP* x Rad. = cos. *PR* x cos. *MR* in which *MP* the middle part is sought, therefore *Radius* must be put in the first place, and then the proportion is.

Rad. cos. *PR* : : cos. *M.R.* cos. *MP*.

CASE 3.

CASE 3.

A Leg with an Angle opposite thereunto being given, to find the other Leg.

In the Right angled Spherical Triangle *MPR*, let there be given. The Leg *MR*. The Angle *P*. The Leg *PR* inquired.

By the first of the 10 Rectangles. Rad. t *MR* :: cot *P*. Sine *PR*. or The Leg *PR* and the Angle *M* given, to find *MR*.

By the 3 of the 10 Rectangles. Rad. t *PR* :: ct *M*. Sine *MR*.

CASE 4.

A Leg with an Angle conterminate therewith being given, to find the other Leg.

In the Right angled Spherical Triangle, *MPR*, The given Leg is *MR*, with the Angle *M*. The Leg *PR* is required.

By the 3 Rectangle. cot. *M*. Rad :: Sine *MR*. t *PR*.

The given Leg *RP*, and Angle *P*. The Leg *MR* is required.

By the 1. Rectangle. ct *P*. Rad :: sine *RP*. tang. *MR*.

CASE 5.

A Leg and an Angle conterminate therewith being given, to find the Hypotenuse.

In the Right angled Spherical Triangle *MPR*, let there be given,

$$\text{The Leg} \left\{ \begin{array}{l} MR \text{ and the Angle } M \\ PR \text{ and the Angle } P \end{array} \right\} \text{to find } MP.$$

By the 5. Rectangle, t *MR*. Rad : : cos. *M*. ct *MP*.
By the 9. Rectangle. t *PR*. Rad. : : cos. *P*. ct *MP*.

CASE 6.

The Hypotenuse and a Leg given, to find the contained Angle.

In the Right angled Spherical Triangle *MPR*, let there be given,

$$\left.\begin{array}{r} \text{The Hypote-} \\ \text{nuse } MP, \end{array}\right\} \begin{array}{c} \text{and} \\ \text{Leg} \end{array} \left\{ \begin{array}{l} MR. \\ PR. \end{array} \right\} \text{To find} \left\{ \begin{array}{l} M. \\ P. \end{array} \right.$$

By the 5. Rectangle, Rad. ct *MP* : : t *MR*. cos. *M*.
By the 9. Rectangle, Rad. ct *MR* : : t *PR*. cos. *P*.

CASE 7.

The Hypotenuse and one Angle given, to find the other Angle.

In the Right angled Spherical Triangle *MPR*, let there be given,

The

The Hypotenuse *MP*	& Angle *M* / *P*.	To find the Angle	*P*. / *M*.

By the 7. Rectangle, cot.*M*. Rad :: cos.*MP*.cot.*R*.
By the 7. Rectangle cot.*P*. Rad :: cos. *MP*.cot.*M*.

CASE 8.

The Oblique Angles given, to find the Hypotenuse.

In the Right angled Spherical Triangle *MPR*, let there be given The Angles at *P* and *M*, To find the Hypotenuse *PM*.

By the 7. Rectangle. Rad. ct *P* :: cot.*M*. cos. *MP*.

CASE 9.

The Hypotenuse and an Angle given, to find the Leg conterminate with the given Angle.

In the Right angled Spherical Triangle *MPR*, let there be given,

The Hypotenuse *PM*	Angle *P*. / *M*.	To find	*PR*. / *MR*.

By the 9. Rectangle, ct *PM*. Rad :: cos. *P*. t *PR*.
By the 5. Rectangle, ct *PM*. Rad :: cos.*M*. t *MR*.

CASE 10.

The Hypotenuse and an Angle given, to find the Leg opposite to the given Angle.

In the Right angled Spherical Triangle *MPR*, let there be given,

$$\text{The Hypotenuse } PM \left\{\begin{array}{c}\text{and the}\\ \text{Angle}\end{array}\right\} \left\{\begin{array}{l}M.\\ P.\end{array}\right\} \text{To find} \left\{\begin{array}{l}PR.\\ MR.\end{array}\right.$$

By the 2. Rectangle, Rad. s *MP* : : s *M*. Sine *PR*.
By the 4. Rectangle, Rad. s *MP* : : s *P*. Sine *MR*.

CASE 11.

A Leg and an Angle opposite thereunto being given, to find the Hypotenuse.

In the Right angled Spherical Triangle *MPR*, let there be given,

$$\text{The Leg} \left\{\begin{array}{l}PR.\\ MR.\end{array}\right\} \left\{\begin{array}{c}\text{and the}\\ \text{Angle}\end{array}\right\} \left\{\begin{array}{l}M\\ P\end{array}\right\} \begin{array}{l}\text{to find the Hy-}\\ \text{potenuse } PM.\end{array}$$

By the 2. Rectangle, s *M*. Rad : : s *PR*. s *MP*.
By the 4. Rectangle, s *P*. Rad : : s *MR*. s *PM*.

CASE 12.

The Hypotenuse and a Leg given, to find the Angle opposite to the given Leg.

In the Right angled Spherical Triangle *PMR*, the

the Hypotenuse *MP* and the Leg *MR* are given, the Angle at *P* is required.

By the fourth Rectangle Sine *MP* to, Rad : : s *MR*. s *P*.

The Hypotenuse *MP* and Leg *PR* given, the Angle *M* is required.

By the second Rectangle. s *MP*. Rad : : s *PR*. s *M*.

CASE 13.

The Angle and Leg conterminate with it being given, to find the other Angle.

In the Right angled Spherical Triangle *PMR*, let there be given,

The Angle		and the Leg		to find the Angle	
	M		*MR*		*P*.
	P		*PR*		*M*.

By the tenth Rectangle, Rad. cs *MR* : : s *M*. cs *P*.
By the sixth Rectangle, Rad. s *P* : : cs *PR*. cs *M*.

CASE 14.

An Angle and a Leg opposite thereunto being given, to find the other Angle.

In the Right angled Spherical Triangle *MPR*, let there be given,

The Angle		and the Leg		to find the Angle	
	P		*MR*		*M*.
	M		*PR*		*P*.

By the 10. Rectangle, cs *MR*. Rad : : cs *P*. cs *M*.
By the 6. Rectangle, cs *PR*. Rad : : cs *M*. s *P*.

CASE 15.

CASE 15.

The Oblique Angles given, to find a Leg.

In the Right angled Spherical Triangle *MPR*, let there be given, the Angles at *M* and *P*, to find the Legs *MR* and *PR*.

By the 10. Rectangle, s *M*. Rad : : cs *P*. cs *MR*.
By the 6. Rectangle, s *P*. Rad : : cs *M*. cs *PR*.

CASE 16.

The Hypotenuse and one Leg given, to find the other Leg.

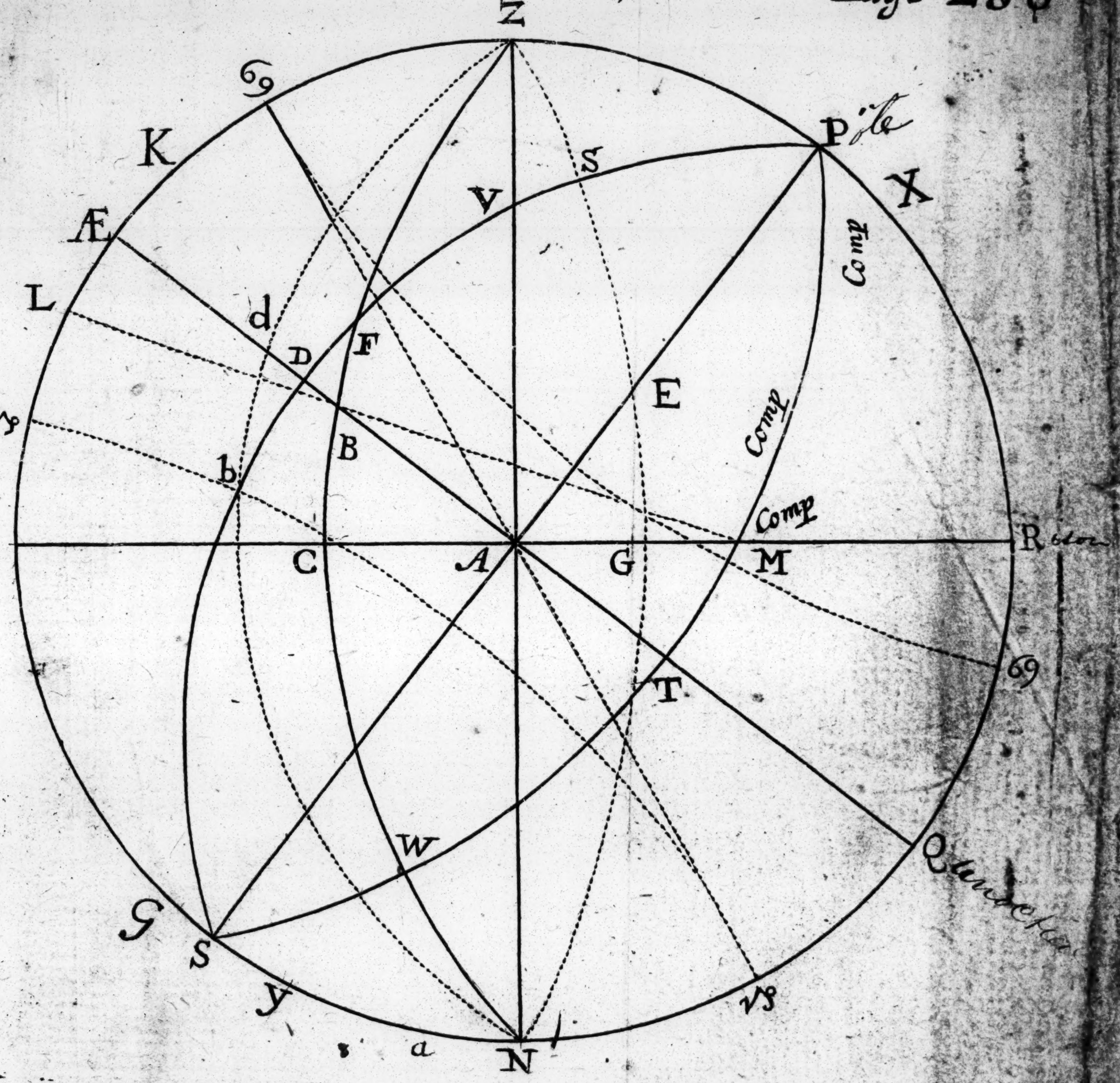
In the Right angled Spherical Triangle *MPR*, let there be given,

The Hypotenuse *MP* and the Leg { *PR* / *MR* } to find the Leg { *MR*. / *PR*.

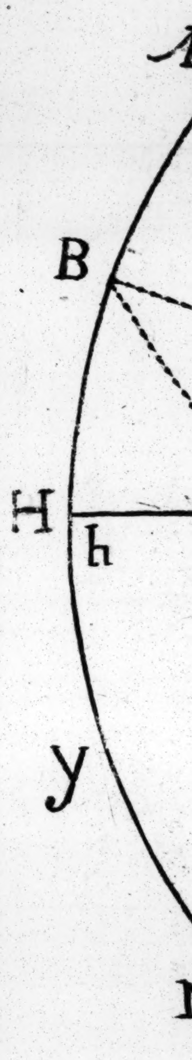
By the 8. Rectangle, { cs *PR*. Rad : : cs *MP*. cs *MR*. / cs *MR*. Rad : : cs *MP*. cs *PR*.

Thus I have given you the Proportions by which the 16 Cases of a Right angled Spherical Triangle may be resolved, In which there are contained 30 Astronomical Problems, Two in every Case except the Second and the Eighth. In both which Cases there are but two Problems. And thus I have done with Right angled Spherical Triangles.

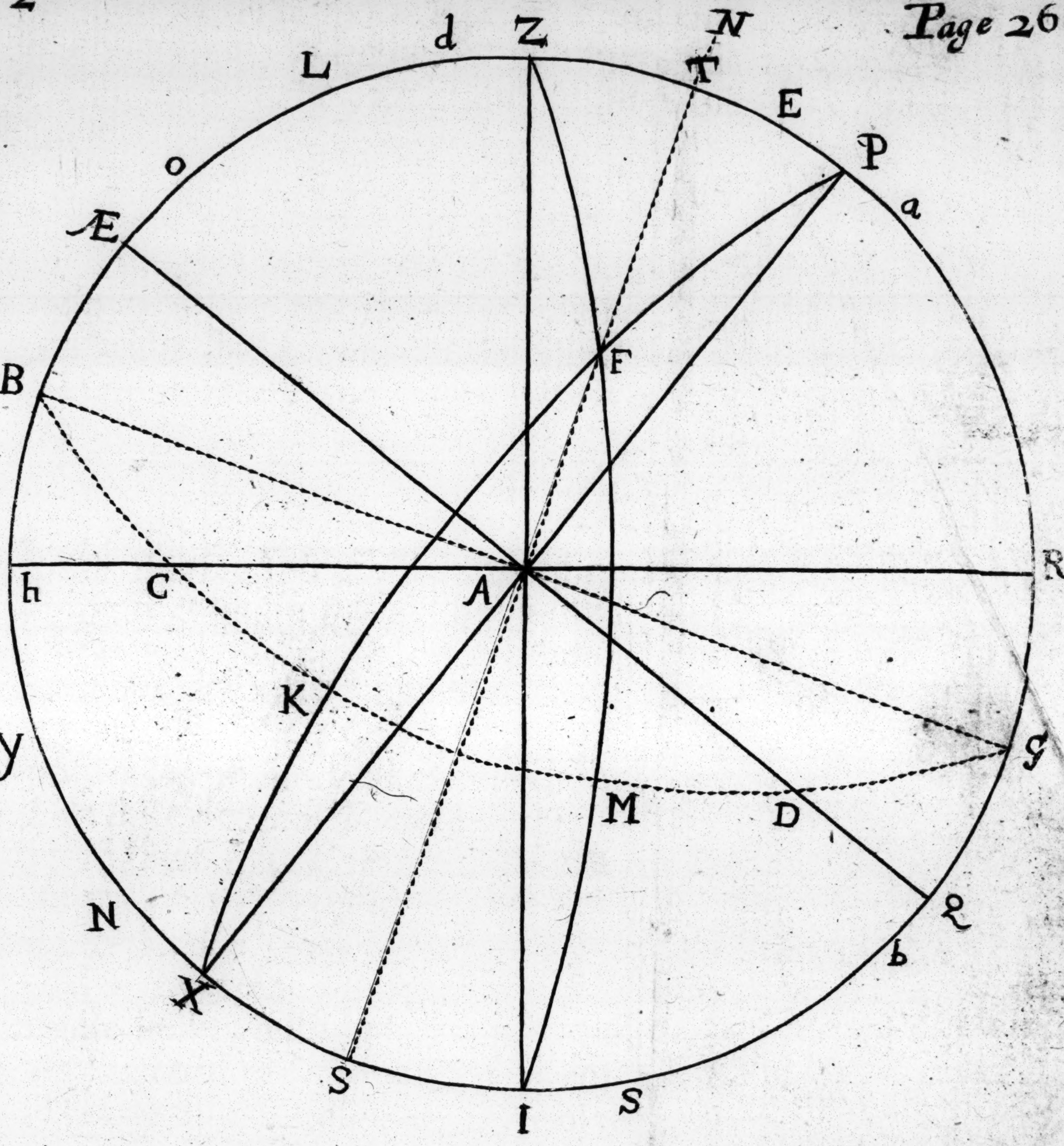
4. In Oblique angled Spherical Triangles there


Z
P
Pole
X
K
Æ
L
S
V
d
D
F
E
B
b
C
A
G
M
R
T
W
Q
S
y
N
Comp
Comp
Comp

2



2



y

there are twelve Cases, ten whereof may be resolved by the Catholick Proposition; If the Spherical Triangle propounded be first converted into two right, by letting fall of a Perpendicular, sometimes within, sometimes without the Triangle.

5. If the Angles at the Base be both acute or both obtuse, the Perpendicular shall fall within the Triangle; but if one of the Angles of the Base be acute and the other obtuse, the Perpendicular shall fall without the Triangle.

6. However the Perpendicular falleth, it must be always opposite to a known Angle, for your better direction, take this General Rule.

From the end of a Side given, being adjacent to an Angle given, let fall the Perpendicular.

As in the Triangle *F P S* in *Fig.* 4. If there were given the Side *F S* and the Angle at *S*, the Perpendicular by this Rule must fall from *F* upon the Side *S P* extended, if need require.

But if there were given the Side *P S* and the Angle at *S*, the Perpendicular must fall from *P* upon the Side *F S*.

7. To divide an Oblique angled Spherical Triangle into two Right, by letting fall a Perpendicular upon the Globe it self, is not necessary, because all the Cases may be resolved without it, but in projection it is convenient to inform the fancy: and seeing the reason by which it is done in projection doth depend upon the nature of the Globe, I will here shew it both ways, first upon the Globe, and then by projection.

8. An

An Oblique angled Spherical Triangle may be divided into two Right, by letting fall a Perpendicular upon the Globe it ſelf, in this manner. In the Oblique angled Spherical Triangle *F P S* in *Fig.* 4. let it be required to let fall a Perpendicular from *P* upon the Side *F S*. Suppoſe the Point *P* to ſtand in the Zenith, where the Arch *F S* ſhall cut the Zodiack, which in this Figure is at *K*, make a mark, and from this Point of Interſection of the Circle upon which the Perpendicular is to fall with the Zodiack, reckon 90 Degrees, which ſuppoſe to be at *P*; a thin Plate of Braſs with a Nut at one end thereof, whereby to faſten it to the Meridian, as you do the Quadrant of Altitude, being graduated as that is, but of a larger extent (for that a Quadrant in this caſe will not ſuffice) being faſtned at *P* and turned about till it cut the Point *L* in the Zodiack, will deſcribe upon the Globe the Arch of a great Circle *P E L*, interſecting the Side *F S* at Right Angles in the Point *E*, becauſe the Point *L* in the Zodiack is the Pole of the Circle *S F K*, now all great Circles which paſſing through the Point *L*, ſhall interſect the Circle *S K G*, ſhall interſect it at Right Angles; by the 13. of the 2. Chapter.

9. And hence to divide an Oblique angled Spherical Triangle into two Right by projection is eaſie, as in the Triangle *F P S*, the Pole of the Circle *S F K* is *L*, therefore the Circle *B L P* ſhall cut the Arch *F S* at Right Angles in the Point *E*. And becauſe the Point *M* is the Pole of the Circle *B F P*, therefore the Circle *G M S* ſhall cut the Circle *B F P* at Right Angles in the Point *D*, the Side *F P* being extended;

ed. Come we now to the several Cases which after this preparation may be resolved, by the Catholick Proposition.

CASE I.

Two Sides with an Angle opposite to one of them being given, to find the Angle opposite to the other.

In the Oblique angled Spherical Triangle *FPS*, in *Fig.* 4. the Sides and Angles given and required will admit of six Varieties; all which may be resolved by the Catholick Proposition, at two operations, but those two may be reduced to one, as by the following Analogies to every Variety will plainly appear.

Given		Required	
	FP		Rad. *s PS* :: *s PSF*. s PE
1.	*PS*	*PFS*	*s PF*. Rad :: s PE. *s PFS*
	PSF		*s PF*. *s PS* :: *s PSF*. *s PFS*
	FP		Rad. *s FP* :: *s F*. s PE
2.	*PS*	*PSF*	*s PS*. Rad :: s PE. *s PSF*
	PFS		*s*. *PS*. *s FP* :: *s PFS*. *s PSF*
	PS		Rad. *s SF* :: *s F*. s DS
3.	*FS*	*FPS*	*s PS*. Rad :: s DS. *s SPD*
	PFS		*s*. *PS*. *s SF* :: *s PFS*. *s PSF*
	PS		Rad. *s PS* :: *s SPD*. s DS
4.	*FS*	*PFS*	*s FS*. Rad :: s DS. *s SF*
	FPS		*s*. *FS*. *s PS* :: *s SPF*. *s SF*
	FS		Rad. *s FS* :: *s S*. s FC
5.	*FP*	*FPS*	*s FP*. Rad :: s FC. *s FPC*
	FSP		*s*. *FP*. *s FS* :: *s PSF*. *s FPS*

FS

FS		Rad. s FP : : s FPC. s FC
6. FP	FSP	s FS. Rad : : sFC. s S
FPS		s. FS. s FP : : FPS. s PSF.

CASE 2.

Two Sides with an Angle appoſite to one of them being given, to find the contained Angle.

In this Caſe there are ſix Varieties, all which may be reſolved by the Catholick Propoſition, according to the Table following.

Given	Required	
FP		1. cot PSF. Rad : : cs PS. ct EPS
1. PS	FPS	2. ct PS. Rad : : cs EPS. t EP
PSF		3. Rad. t EP : : ct FP. cs FPE
EPS + FPE = FPS		ct PS. cs EPS : : ct FP. ct FPE
FP		1. cot PFS. Rad : : cs PF. ct EPF
2. PS	FPS	2. ct PF. Rad : : cs EPF. t EP
PFS		3. Rad. t EP : : cot PS. cs EPS
EPS + EPF = FPS		cot PF. cs EPF : : ct PS ct EPS
PS		1. cot PFS. Rad : : cs FS. ct FSD
3. FS	PSF	2. ct FS. cs FSD : : Rad. t DS
PFS		3. Rad. t DS : : ct PS. cs PSD
FSD -- PSD = PSF		ct FS. cs FSD : : ct PS. cs PSD
PS		1. cot FPS. Rad : : cs PS. ct PSD
4. FS	PSF	2. ct PS. cs PSD : : Rad. t DS
FPS		3. Rad. t DS : : ct FS. cs FSD
FSD -- PSD = PSF		ct PS. cs PSD : : ct FS. cs FSD
FS		1. cot FSP. Rad : : cs FS. ct SFC
5. FP	PFS	2. ct FS. cs SFC : : Rad. t FC
FSP		3. Rad. t FC : : ct FP. cs PFC
SFC — PFC = PFS		ct FS. cs SFC : : ct FP. cs PFC

FS 6. FF PFS FPS SFC—PFC = PFS	1. cot FPS. Rad :: cs FP. ct PFC 2. cot FP. cs PFC :: Rad. t FC 3. Rad. t FC :: ct FS. cs SFC ct FP. cs PFC :: ct FS. cs SFC.

CASE 3.

Two Sides and an Angle opposite to one of them being given, to find the third side.

The Varieties in this Case, with their resolution by the Catholick Proposition, are as followeth.

Given Reqnired	
FP 1. PS FS PSF ES + FE = FS	1. ct PS :: cs PSF. t ES 2. cs ES. cs PS :: Rad. cs EP 3. Rad. cs EP :: cs FP. cs FE cs ES. cs PS :: cs FP. cs FE
FP 2. PS FS PFS SE + FE = FS	1. cot FP. Rad :: cos PFS. t FE 2. cos FE. cos FP :: Rad. cos EP 3. Rad. cos EP :: cos PS. cos SE cos FE. cos FP :: cos PS. cos SE
PS 3. FS FP PFS FD—PD = FP	1. cot FS. Rad :: cos PFS. t FD 2. cos FD. cos FS :: Rad. cs SD 3. Rad. cos SD :: cos PS. cs PD cos FD. cos FS :: cs PS. cs PD
PS 4. FS FP FPS FD—PD = FP	1. cot PS. Rad :: cos FPS. t PD 2. cos PD. cos PS :: Rad. cos SD 3. Rad. cos SD :: cos FS. cs FD cos PD. cos PS :: cos FS. cs FD

FS

FS 5. FP FSP SC—PC=PS	PS	1. *cot* FS. *Rad* : : *cos* FSP. *t* SC 2. *cos* SC. *cos* FS : : Rad. cos FC 3. Rad. cos FC : : *cos* FP. *cos* PC *cos* SC. *cos* FS. *eos* FP. *cos* PC
FS 6. FP FPS SC—PC=PS	PS	1. *cot* FP. *Red* : : *cos* FPS. *t* PC 2. *cos* PC. *cos* FP : : Rad. cos FC 3. Rad. cos FC : : *cos* FS. *cos* SC *cos* PC. *cos* FP : : *cos* FS. *cos* SC

CASE 4.

Two Angles with a Side opposite to one of them being given, to find the Side opposite unto the other.

The Varieties in this Case, with their Resolution by the Catholick Proposition, are as followeth.

Given	Required	
PFS 1. FPS PS	FS	Rad. *s* PS : : *s* DPS. s SD s. FP. Rad : : s SD. *s* FS *s*. PFS. *s* PS : : *s* FPS. *s* FS
PFS 2. FPS FS	PS	Rad. *s* FS : : *s* PFS. s SD *s*. FPS. Rad : : s SD. *s* PS *s*. FPS. *s* FS : : *s* PFS. *s* FS
FPS 3. PSF FP	FS	Rad. *s* FP : : *s* FPS. s FC *s*. PSF. Rad : : s FC. *s* FS *s*. PSF. *s* FP : : *s* FPS. *s* FS

FPS

4.	*FPS* *PSF* *FS*	*FP*	Rad. *s FS* :: *s PSF*. s FC *s. FPS*. Rad :: s FC. *s FP* *s. FPS s FS* :: *s PSF. s FP*
5.	*PSF* *SFP* *PS*	*FP*	Rad. *s PS* :: *s PSF*. s PE *s. SFP*. Rad :: s PE. *s FP* *s. SFP. s PS* :: *s PSF. s FP*
6.	*PSF* *SFP* *FP*	*PS*	Rad. *s FP* :: *s PFS*. s PE *s. PSF*. Rad :: s PE. *s PS* *s. PSF. s FP* :: *s PFS. s PS*

CASE 5.

Two Angles and a side opposite to one of them being given, to find the Side between them.

The Varieties and Proportions, are as followeth.

Given		Required	
1.	*PFS* *FPS* *PS* *FD—PD=FP*	*FP*	1. *ct PS. Rad* :: *cs DPS. PD* 2. *ct DPS. s PD* :: Rad. t DS 3. Rad. t DS :: *ct PFS. s FD* *ct DPS. s PD* :: *ct PFS. s FD*
2.	*PFS* *FPS* *FS* *FD—PD=FP*	*FP*	1. *ct DFS. Rad* :: *cs PFS. t FD* 2. *cot PFS. s FD* :: *Rad. t DS* 3. *Rad. t DS* :: *ct FPS. s PD*
3.	*FPS* *PSF* *FP* *SC—PC=PS*	*PS*	1. *cot FP. Rad* :: *cs FPC. t PC* 2. *cot FPC. s PC* :: Rad. t FC 3. Rad. t FC :: *ct PSF. s SC* *cot FPC. s PC* :: *ct PSF. CS*

FPS 4. PSF PS FS SC--PC = PS	1. cot FS. Rad :: cs PSF. t SC 2. cot PSF. s SC :: Rad. t FC 3. Rad. t FC :: cot FPS. s PC cot PSF. s SC :: cot FPS. s PC
PSF 5. SFP FS PS FE + SE = FS	1. cot PS. Rad :: cs PSF. t SE 2. cot PSF. s SE :: Rad. t PE 3. Rad. t PE :: cot SFP. s FE cot PSF. s SE :: cot SFP. s FE
PSF 6. SFP FS FP FE + SE = FS	1. cot FP. Rad :: cs SFP. t FE 2. cot SFP. s FE :: Rad. t PE 3. Rad. t PE :: cos PSF. s SE cot. SFP. s FE :: cs PSF. s SE

CASE 6.

Two Angles and a Side opposite to one of them being given, to find the third Angle.

The Varieties and Proportions are as followeth.

Given Required	
PFS 1. FPS PSF FS FSD--PSD = PSF	1. ct DPS. Rad :: cs PS. ct PSD 2. s PSD. cs DPS :: Rad. cs DS 3. cs DS. Rad :: cs DFS. s FSD cs DPS. s PSD :: cs DFS. s FSD
PFS 2. FPS PSF FS FSD--PSD = PSF	1. ct PFS. Rad :: cs FS. ct FSD 2. s FSD. cs PFS :: Rad. cs DS 3. cs PDS. Rad :: cs DPS. cs PSD cs PFS. s FSD :: cs DPS. cs PSD

FPS

	Given	Required	Proportions
3.	*FPS* *PSF* *FP* *SFC—PFC = PFS*	*PFS*	1. *ct FPC. Rad* :: *cs FP. ct PFC* 2. *s PFC. cs FPC* :: Rad. cs FC 3. cs FC. Rad :: *cs PSF. s FC* *cs FPC. s PFC* :: *cs PSF. s SFC*
4.	*FPS* *PSF* *FS* *SFC—PFC = PFS*	*PFS*	1. *cot PSF. Rad* :: *cos FS. ct SFC* 2. *s SFC. cs PSF* :: Rad. cs FC 3. cs FC. Rad :: *cs CPF. s PFC* *cs PSF. s SFC* :: *cs CPF. s PFC*
5.	*PSF* *SFP* *PS* *FPE+SPE = FPS*	*FPS*	1. *cot PSF. Rad* :: *cs PS. ct SPE* 2. *s SPE. cs PSF* :: Rad. cs PE 3. cs PE. Rad :: *cs SFP. s FPE* *cs PSF. s SPE* :: *cs SFP. s FPE*
6.	*PSF* *SFP* *FP* *FPE+SPE = FPS*	*FPS*	1. *cot SFP. Rad* :: *cs FP. ct FPE* 2. *s FPE. cs SFP* :: Rad. cs PE 3. cos PE Rad :: *cs PSF. s SPE* *cs SFP. s FPE* :: *cs PSF. s SPE*

CASE 7.

Two Sides and their contained Angle being given, to find either of the other Angles.

The Varieties and Proportions are as followeth.

	Given	Required	
1.	*FS* *FP* *PFS* *FS—FE = ES*	*FSP*	1. *ct FP. Rad* :: *cs PFS. t FE* 2. *ct PFS. s FE* :: Rad. t PE 3. t PE. Rad. :: *s ES. ct PSF* *s EF. ct PFS* :: *s ES. ct PSF*

FS 2. FP PFS FD—FP = PD	FPS	1. cot FS. Rad : : cs PFS. t DF 2. cot PFS. s DF : : Rad. t DS 3. t DS. Rad : : s PD. ct SPD s DF. ct PFS : : s PD. ct SPD
FP 3. PS FPS PS + PC = CS	PSF	1. cot FP. Rad : : cos FPC. t PC 2. cot FPC. s PC : : Rad. t FC 3. t FC. Rad : : s CS. cot FSP s PC. ct FPC : : s CS. ct FSP
FP 4. PS FPS FP + PD = FD	SFP	1. cot PS. Rad : : cos SPD. t PD 2. cot SPD. s PD : : Rad. t DS 3. t DS Rad : : s FD. cot SFP s PD. ct SPD : : s FD. cot SFP
PS 5. FS PSF FS—SE = FE	SFP	1. cot PS. Rad : : cs PSF. t SE 2. cot PSF. s SE : : Rad. t PE 3. t PE. Rad : : s FE. cot SFP s SE. ct PSF : : s FE. ct SFP
PS 6. FS PSF SC—PS = PC	FPS	1. cot FS. Rad : : cs PSF. t SC 2. cot PSF. s SC : : Rad. t FC 3. t FC. Rad : : s PC. cot FPC s SC. cot PSF : : s PC. ct FPC

CASE 8.

Two Sides and their contained Angle being given, to find the third Side.

The Varieties and Proportions are as followeth.

Given	Required	
FS		1. ct FP. Rad :: cs PFS. t FE
1. FP	PS	2. cs FE. cs FP :: Rad. cos PE
PFS		3. Rad. cs PE :: cs ES. cs PS
FS—FE = ES		cs FE. cs FP :: cs ES. cs PS
FP		1. ct PS. Rad :: cs SPD. t PD
2. SP	FS	2. cs PD. cs PS :: Rad. cos DS
FPS		3. Rad. cos DS :: cs FD. cs FS
FP + PD = FD		cs PD. cs PS :: cs FD. cs FS
PS		1. ct PS. Rad :: cs PSF. t. ES
3. FS	FP	2. cs ES. cs PS :: Rad. cos PE
PSF		3. Rad. cos PE :: cos FE. cos FP
FS—ES = FE		cs ES. cs PS :: cos FE. cs FP

4 CASE 9.

Two Angles and their contained Side being given, to find one of the other Sides.

Given	Required	
PFS		1. ct PFS. Rad :: cs FP ct FPE
1. FPS	PS	2. ct FP. cs FPE :: Rad. t PE
FP		3. t PE. Rad :: cs EPS. ct PS
FPS—FPE = EPS		cs FPE. ct FP :: cs EPS. ct PS
PFS		1. cot FPC. Rad :: cs FP. t PFC
2. FPS	FS	2. cot FP. cs PFC :: Rad. t FC
FP		3. t FC. Rad :: cs SFC. ct SF
SFP + PFC = SFC		ct FP. cs PFC :: cs SFC. ct SF

FPS 3. PSF SF PS PSF+PSD=FSD	1. ct SPD.Rad :: cs PS.ct PSD 2. ct PS. cos PSD :: Rad. t DS 3. t DS. Rad :: cs FSD.ct SF cs PSD.ct PS :: cs FSD.ct SF
FPS 4. PSF FP PS FPS--EPS=FPE	1. ct PSF. Rad :: cs PS.ct SPE 2. ct PS. cs SPE :: Rad. t PE 3. t PE. Rad :: cs FPE. ct FP cs SPE.ct PS :: cs FPE.ct FP
PSF 5. SFP FP SF SFC--SFP=CFP	1. ct PSF.Rad :: cs SF.ct SFC 2. ct SF. cs SFC :: Rad. t FC 3. t FC. Rad :: cs CFP. ct FP cs SFC.ct SF :: cs CFP.ct FP
PSF 6. SFP PS SF FSD--FSP=PSD	1. ct SFP.Rad :: cs FS.ct FSD 2. ct FS. cs FSD :: Rad. t SD 3. t SD. Rad :: cos PSD.ct PS cs FSD.ct FS :: cs PSD.ct PS

CASE 10.

Two Angles and the Side between them being given, to find the third Angle.

The Varieties and Proportions are as followeth.

Given Required	
SFP 1. FPS PSF FP FPS—FPE=EPS	1. ct SFP. Rad :: cs FP.ct FPE 2. s FPE. cs F :: Rad. cs PE 3. Rad. cs PE :: s EPS. cs PSF s FPE. cs PFS :: s SPE. cs PSF

FPS

	FPS		1. ct SPD. Rad :: cs PS. ct PSD
2.	PSF	SFP	2. s PSD. cs SPD :: Rad. cs DS
	PS		3. Rad. cs DS :: s FSD. cs SFP
	PSF + PSD = FSD		s PSD. cs SPD :: s FSD. cs SFP
	PSF		1. ct PSF. Rad :: cs SF. ct SFC
3.	SFP	FPS	2. s SFC. cs PSF :: Rad. cs FC
	SF		3. Rad. cs FC :: s PFC. cs FPS
	SFC — SFP = PFC		s SFC. cs PSF :: s PFC. cs FPS

5 CASE II.

The three Sides being given, to find an Angle.

This Case may be resolved by the Catholick Proposition also, according to the direction of the Lord *Nepier*, as I have shewed at large in the Second Book of my *Trigonometria Britannica, Chap.* 2. but may as I conceive be more conveniently solved, by this Proposition following.

1 As the Rectangle of the Square of the Sides containing the Angle inquired;

Is to the Square of *Radius*: So is the Rectangle of the Square of the difference of each containing Side, and the half sum of the three Sides given.

To the Square of the Sine of half the Angle inquired.

In this Case there are three Varieties, as in the Triangle F Z P. Fig. 3.

Method II. from ½ the sum of the three sides take the side opposite to the angle sought, and add the arithmetical complements of the sines of the two containing sides and the sines of ½ the sum and remainder and ½ the sums of these four is the cosine of ½ the angle sought

4 Take the sume and difference of ½ the Base and half the difference of the sides, & then + the sines of this sum and difference, and the arith. comp: of the sines of the containing sides, & ½ the sum of these is the sine of ½ the angle sought

Given		Required	
1.	ZP PF FZ	ZPF	$s\,ZP \times s\,PF.\ Rad.\ q.$ $s\,\frac{1}{2}Z - ZP \times s\,\frac{1}{2}Z - PF.\ Q$ $s\,\frac{1}{2}\,ZPF$
2.	ZP PF FZ	PFZ	$s\,PF \times s\,PZ.\ Rad.\ q.$ $s\,\frac{1}{2}Z - PF \times s\,\frac{1}{2}Z - FZ.\ Q$ $s\,\frac{1}{2}\,PFZ$
3.	ZP PF FZ	FZP	$s\,ZP \times s\,FZ\ Rad.\ q.$ $s.\,\frac{1}{2}Z - ZP \times \frac{1}{2}Z - ZF.\ Q$ $s\,\frac{1}{2}\,FZP$

6 CASE 12.

The three Angles given, to find a Side.

This is the Converse of the last, and to be resolved after the same manner, if so be we convert the Angles into Sides, by the tenth of the third Chapter: for so the Sides of the Triangle *ACD* will be equal to the Angles of the Triangle *FZP* n *Fig.* 3.

That is
- *AD* = *ÆE* the measure of the Angle *ZPF*.
- *DC* = *KM* the measure of the Angle *ZFP*.
- *AC* = *HB* the Complement of *FZP* to a Semicircle.

T

The

The Angle $\begin{cases} DAC = QR = ZP. \\ ACD = rM = Hf = Z\,æ = ZF. \\ ADM = sK = Æl = Ph = PF. \end{cases}$

And thus the Sides of the Triangle *ZPF* are equal to the Angles of the Triangle *ACD*. The Complement of the greatest Side *PF* to a Semicircle being taken for the greatest Angle *ADC*.

And in this Case therefore, as in the preceding, there are three Varieties which make up sixty Problems in every Oblique angled Spherical Triangle; which actually to resolve in so many Triangles, as have been mentioned, would be both tedious, and to little purpose; I will therefore select some few, that are of most general use in the Doctrine of the Sphere, and leave the rest to thine own practice.

CHAP. V.

CHAP. V.

Of such Spherical Problems as are of most General Use in the Doctrine of the Primum Mobile *or Diurnal Motion of the Sun and Stars.*

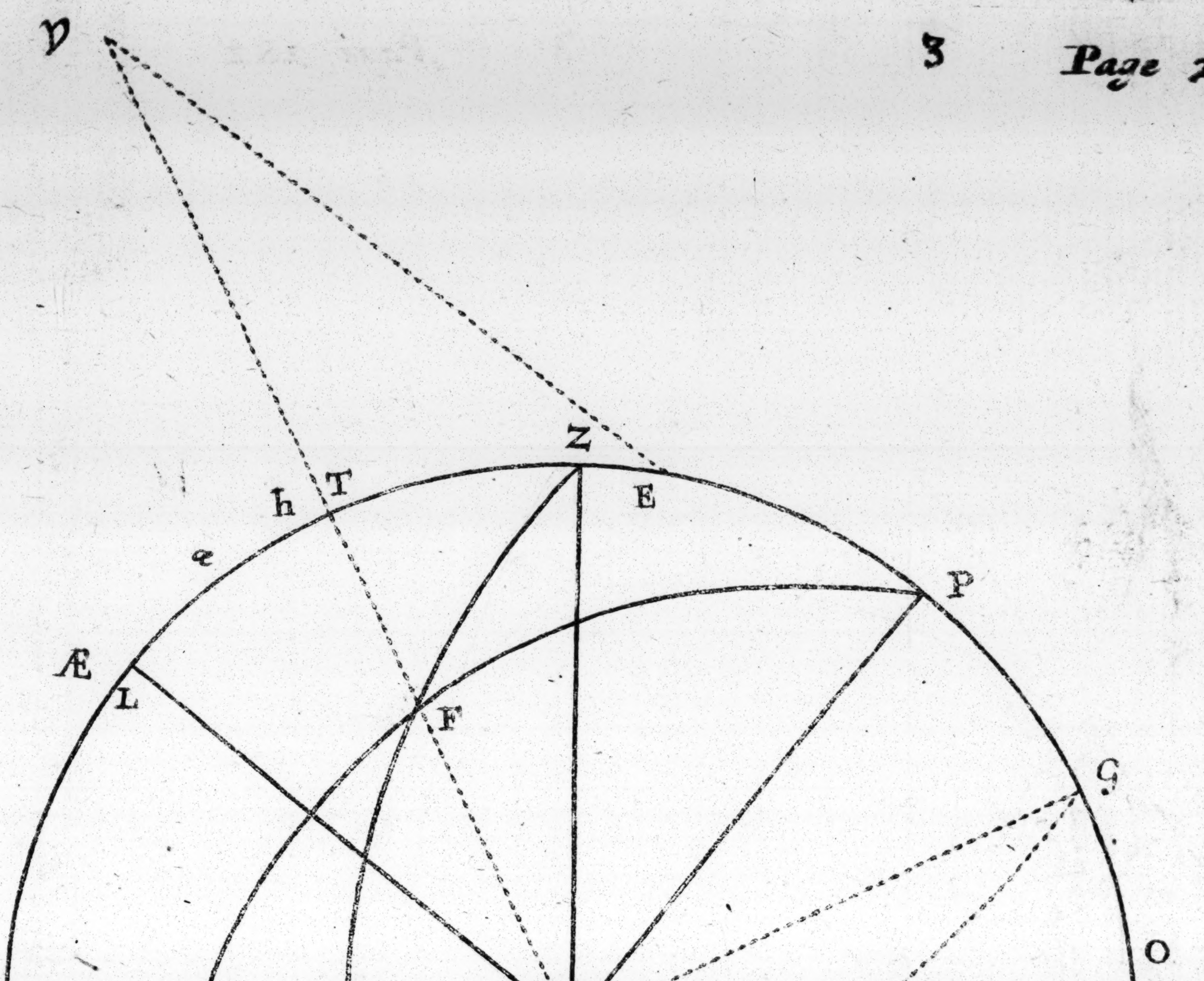
PROBLEM I.

The greatest Declination of the Sun being given, to find the Declination of any Point of the Ecliptick.

THe Declination of the Sun or other Star, is his or their distance from the *Equator*, and as they decline from thence either Northward or Southward ; so is their Declination reckoned North or South.

2. The Sun's greatest Declination, which in this and many other Problems is supposed to be given, with the Distance of the Tropicks, Elevation of the *Equator*, and Latitude of the Place, may thus be found.

Take with a Quadrant, the Sun's greatest and least Meridian Altitudes, on the longest and shortest days of the year, which suppose at *London* to be as followeth.


Y
Z
T
h
E
e
P
Æ
L
F
G
O
V
R
A
C
Q
D
q
B
M
ℓ
K
f
P
g
y
Q
X
m
d
b
n
S
I

30
~~66~~

~~1680~~

17

23 " 27 .. 56
17

23 " 27 " 39

57

30) 4"

90 | 9".7
·48"

The Sun's { greatest / least } Meridian Altitude { H♋. 61°.9916 / H♑. 14°.9416

Their difference is the distance of the Tropicks } ♋.♑. 47°. 050

Half that Difference, is the Sun's greatest Declination } Æ♋. 23°. 525 23°‥27′‥39

Which deduct from the Sun's greatest Altitude, the remainer is the height of the *Equator* } HÆ. 38°. 467 90 / 51.5 / 38.5

The Complement is the height of the Pole } *ÆZ* or *PR*. 51°. 533

Now, then in the Right angled Spherical Triangle *ADF* in *Fig.* 1. there being given.

1. The Angle of the Sun's greatest Declination *DAF*. 23. 525.

2. The Sun's supposed distance from ♈ to ♎ *AF*. 60 deg.

The Sun's present Declination *DF* may be found, by the 10 Case of Right angled Spherical Triangles.

As the *Radius*.

Is to the Sine of *DAF*. 23. 525.	9. 60113517
So is the Sine of *AF* 60.	9. 93753063
To the Sine of *DF*. 20. 22.	9. 53866580

PROBLEM 2.

PROBLEM 2.

The Sun's greatest Declination, with his Distance from the next Æquinoctial Point being given, to find his Right Ascension.

In the Right angled Spherical Triangle *ADF* in *Fig.* 1. Having the Angle of the Sun's greatest Declination *DAF*. 23. 525. And his supposed distance from ♈ or ♎, the *Hypotenusa AF*. 60. The Right Ascension of the Sun, or Arch of the *Æquator*, *AD* may be found, by the ninth Case of Right angled Spherical Triangles,

As the Cotang. of the Hypot. *AF*. 60.	9.76143937
Is to the *Radius*	10. 00000000
So is the Cosine of *DAF*. 23.525.	9 96231533
To the Tang. of *AD*. 57. 80.	10. 20087596

PROBLEM 3.

To find the Declination of a Planet or Fixed Star with Latitude.

In the Oblique angled Spherical Triangle *FPS* in *Fig.* 4. we have given, 1. *PS* = Æ♋ the greatest Declination of the Ecliptick, 2. The Side *FS* the Complement of the Stars Latitude from the Ecliptick at *K*. 3. The Angle *PSF* the Complement of the Stars Longitude. To find *PF* the Complement of Declination. By the eighth Case of Oblique angled Spherical Triangles, the Proportions are.

As

As the Cot. of *P S*. 23. 525. 10. 3611802
Is to the *Radius*. 10. 0000000
So is the Cos. of *P S F*. 20 deg. 9. 9729858
To the Tang. of *S E*. 22. 25. 9. 6118056

F S. 86 deg. — *E S*. 22. 25. = *F E*. 63. 75.

As the Cos. of *E S*. 22. 25. *Comp. Arith*. 0. 0336046
To the Cosine of *P S*. 23. 525. 9. 9623154
So the Cos. *F E*. 63. 75. 9. 6457058
To the Cos. *P F*. 64. 01. 9. 6416258

Whose Complement, is *F T*. 25. 99. the Declination sought.

PROBLEM 4.

To find the Right Ascension of a Planet, or other Star with Latitude.

The Declination being found by the last Problem, we have in the Oblique angled Spherical Triangle *P F S* in *Fig*. 4. All the Sides with the Angle *F S P* 20 deg. or the Complement of the Stars Longitude. Hence to find *F P S* by the first Case of Oblique angled Spherical Triangles, I say

As the Sine of *P F*. 64. 01. *Comp. Arith*. 0. 0463059
Is to the Sine of *F S P*. 20. 9. 5340516
So is the Sine of *F S*. 86. 9. 9984407
To the Sine of *F P S*. 22. 28. 9. 5787982

Whose Complement 67. 72. is the Right Asc. of a Star ♊. 10. North Lat. 4. PRO-

PROBLEM 5.

The Poles Elevation, Sun's greatest Declination and Meridian Altitude being given, to find his true place in the Zodiack.

If the Meridian Altitude of the Sun be less than the height of the *Æquator*, deduct the Meridian Altitude from the height of the *Æquator*, the Remainer is the Sun's Declination towards the South Pole: but if the Meridian Altitude of the Sun be more than the height of the *Æquator*, deduct the height of the *Æquator* from the Meridian Altitude, what remaineth, is the Sun's Declination towards the North Pole, in these Northern Parts of the World: the contrary is to be observed in the Southern Parts.

Then in the Right angled Spherical Triangle *ADF* in *Fig.* 1. we have given the Angle *FAD* the Sun's greatest Declination.

The Leg *DF* the Sun's present Declination, To find *AF* the Sun's distance from the next Equinoctial Point.

Therefore by the Case of Right angled Spherical Triangles.

As the Sine of *FAD*. 23. 525. *Comp. Ar.*	0. 3988648
Is to the Sine of *DF*. 23. 5.	9. 5945468
So is the *Radius*.	10. 0000000
To the Sine of *AF*. 80. 04.	9. 9934116

PROBLEM 6.

PROBLEM 6.

The Poles Elevation and Sun's Declination being given, to find his Amplitude.

The Amplitude of the Sun's rising or setting is an Arch of the Horizon intercepted betwixt the *Æquator* and the place of the Sun's rising or setting; and it is either Northward or Southward, the Northward Amplitude is when he riseth or setteth on this Side of the *Æquator* towards the North Pole; and the Southern when he riseth or setteth on that Side of the *Æquator* which is towards the South Pole: That we may then find the Sun's Amplitude or Distance from the East or West Point, at the time of his rising or setting. In the Right angled Spherical Triangle *ATM*, in *Fig.* 2. let there be given the Angle *TAM*. 38. 47. the Complement of the Poles Elevation; and *TM*. 23. 15. the Sun's present Declination: To find *AM* the Sun's Amplitude.

By the eleventh Case of Right angled Spherical Triangles.

As the Sine of *MAT*. 38.47. *Comp. Ar.*	0. 2061365
Is to the *Radim.*	10. 0000000
So is the Sine of *MT*. 23. 15.	9. 5945468
To the Sine of *AM*. 39. 19.	9. 8006833

PROBLEM 7.

PROBLEM 7.

To find the Aſcenſional Difference.

The Aſcenſional Difference is nothing elſe, but the Difference between the Aſcenſion of any Point of the Ecliptick in a Right Sphere, and the Aſcenſion of the ſame Point in an Oblique Sphere; As in *Fig.* 1. *AT* is the Aſcenſional difference between *DA* the Sun's Aſcenſion in a Right Sphere, and *DT* the Sun's Aſcenſion in an Oblique Sphere. Now then in the Right angled Spherical Triangle *AMT*, we have given. The Angle *MAT*. 38. 47. the Complement of the Poles Elevation. And *MT*. 23. 15. To find *AT* the Aſcenſional difference.

As *Rad.*	
To the Cot. of *MAT*. 38. 47. *Com. Ar.*	10.0999136
So is Tang. *MT*. 23. 55.	9.6310051
To the Sine of *AT*. 32. 56.	9.7309187

PROBLEM 8.

Having the Right Aſcenſion and Aſcenſional Difference, to find the Oblique Aſcenſion and Deſcenſion.

In *Fig.* 1. *DT* repreſents the Right Aſcenſion, *AT* the Aſcenſional Difference. *DA* the Oblique Aſcenſion which is found by deducting the Aſcenſional Difference *AT*. from the Right Aſcenſion *DT*. according to the Direction following.

If

If the Declination be		
N. North	Subt.	The Ascentional Difference from the Right, and it giveth the Oblique Ascension.
	Add	The Ascensional Difference to the Right, and it giveth the Oblique Descension.
South	Add	The Ascensional Difference to the Right, and it giveth the Oblique Ascension.
	Subt.	The Ascensional Difference from the Right, and it giveth the Oblique Descension.

Right Ascension of ♊. 0 deg.	57. 80
Ascensional Difference	27. 62
Oblique Ascension ♊. 0 deg.	30. 18
Oblique Descension ♊. 0 deg.	85. 42

PROBLEM 9.

To find the time of the Sun's rising and setting, with the length of the Day and Night.

The Ascensional Difference of the Sun being added to the Semidiurnal Arch in a Right Sphere, that is, to 90 Degrees in the Northern Signs, or substracted from it in the Southern, their Sum or Difference will be the Semidiurnal Arch, which

doubled is the Right Arch, which bisected is the time of the Sun rising, and the Day Arch bisected is the time of his setting.

As when the Sun is in 0 deg. ♊. his Ascensional Difference is 27. 62. which being added to 90 degrees, because the Declination is North, the Sum will be 117.62 the Semidiurnal Arch.

The double whereof is 235.22 the Diurnal Arch, which being converted into time makes 15 hours 41 minutes: for the length of the Day, whose Complement to 24; is 8 hours 19 minutes the length of the Night; the half whereof is 4 hours 9 minutes 30 Seconds the time of the Sun's rising.

PROBLEM 10.

The Poles Elevation and the Sun's Declination being given, to find his Altitude at any time assigned.

In this Problem there are three Varieties. 1. When the Sun is in the *Æquator*, that is, in the beginning of ♈ and ♎ in which case supposing the Sun to be at *B*, 60 degrees or four hours distant from the Meridian, then in the Right angled Spherical Triangle *B Z Æ*, in *Fig* 1. we have given, *Æ Z*, 51.53. the Poles Elevation, and *B Æ* 60 degrees, to find *B Z*.

Therefore by the 2 Case of Right angled Spherical Triangles.

As the *Radius*

To the Cosine of *ÆZ*.	51. 53.	9. 7918635
So is the Cosine of *BÆ*.	60.	9. 6989700
To the Cosine of *B Z*.	71. 88.	9. 4928335

Whose Complement *BC*. 18. 12. is the ☉ Altitude required.

The second Variety is when the Sun is in the Northern Signs, that is, in ♈. ♉. ♊. ♋. ♌. ♍. in which Case supposing the Sun to be at *F* in *Fig.* 1. Then in the Oblique angled Spherical Triangle *F Z P*, we have given. 1. *P Z* 38. 47 the Complement of the Poles Elevation. 2. *FP* 67. 97 the Complement of Declination. 3. *ZPF* 45 the Distance of the ☉ from the Meridian, To find *F Z*.

Therefore by the eighth Case of Oblique angled Spherical Triangles.

As the Cotang. of *Z P*.	38. 47.	10. 0997059
Is to the *Radius*.		10. 0000000
So is the Cosine of *Z P F*.	45.	9. 8494850
To the Tang. of *S P*.	29. 33.	9. 7497791

Then from *F P*.	67.	97
Deduct *S P*.	29.	33
There rests *F S*.	38.	64

As the Cosine of *S P*. 29.33. *Comp. Ar.*	0.0595768
To the Cosine of *PZ*. 38.47.	9.8937251
So is the Cosine of *F S*. 38. 64.	9.8926982
To the Cosine of *F Z*. 45. 45.	9.8460001

Whose Complement *F C*. 44. 55 is the ☉ Altitude required.

The third Variety is when the Sun is in the Southern Signs as in ♎. ♏. ♐. ♑. ♒. ♓. And in this Case supposing the ☉ to be ♐ 10 degrees, and his Declination South *D b* 22. 03. and his Distance from the Meridian 45 as before, then in the Oblique angled Spherical Triangle *Z b P* in *Fig*. 1. we have given *Z P*. 38. 47. The Side *b P* 112. 03. and the Angle *Z P b* 45. To find *Z b*.

Therefore by the 8 Case of Oblique angled Spherical Triangles.

As the Cotang. of *Z P*. 38. 47.	10.0997059
Is to the *Radius*.	10.0000000
So is the Cosine of *Z P b*. 45.	9. 8494850
To the Tang. of *S P*. 29. 33.	9.7497791

Then from *b P*.	112. 03
Deduct *S P*.	29. 33
There rests *b S*.	82. 70

As the Cosine of *P S*. 29.33. *Comp. Ar.*	0.0595768
To the Cosine of *Z P*. 38. 47.	9.8937251
So the Cosine of *b S*. 82.70	9.1040246
To the Cosine of *Z b*. 83. 45.	9.0573265

Whose Complement 6. 55 is the ☉ Altitude required.

PROBLEM 11.

PROBLEM 11.

Having the Altitude of the Sun, his Distance from the Meridian, and Declination, to find his Azimuth.

The *Azimuth* of the Sun is an Arch of the Horizon intercepted between the Meridian and the Vertical Line passing by the Sun, being understood by the Angle *HZC* in *Fig.* 1. or Arch *HC*. And in all the Varieties of the last Problem, may be found, by the first Case of Oblique angled Spherical Triangles.

Thus in the Triangle *ZBP*.

As the Sine of *BZ*. 71.88. *Comp. Ar.*	0.0220903
Is to the Sine of *BPZ*. 60.	9.9375306
So is the Sine of *BP*. 90.	10.0000000
To the Sine of *BZP*. 65.67.	9.9596209

In the Triangle *ZFP*. I say.

s. ZF. s. ZPF :: s. FP. s. FZP.

In the Triangle *ZbP*. I say.

Sine *Zb*. Sine *ZPb* :: Sine *bP*. Sine *bZP*.

PROBLEM 12.

The Poles Elevation, with the Sun's Altitude and Declination given, to find his Azimuth.

In the Oblique angled Spherical Triangle *FZP* in *Fig.* 1. let there be given.

1. *FP*. 67. 97 the Complement of the ⊙ Declination.
2. *ZP*. 38. 47 the Complement of the Poles Elevation.
3. *FZ*. 45. 46 the Complement of the ⊙ Altitude.

And let the Angle *FZP* the ⊙ *Azimuth* be required.

By the 11 Case of Oblique Angled Spherical Triangles.

As the Sine *ZP* × Sine *FZ*, Is to the Square of *Radius*.
So is the Sine ½ Z of the Sides *ZP* × ½ *Z cr* — *ZF*.
To the Square of the Sine of half the Angle *FZP*.
The Sum of the three Sides is 151 . 89
The half Sum is 75. 945 from which deduct *PZ* 38. 47. The difference is 37. 475
And the Difference between 75. 945 and *FZ* is 30. 495.

Sine

Sine of PZ. 38.47. *Comp. Ar.*	0.2061365
Sine of FZ. 45.45. *Comp. Ar.*	0.1471308
$s.\frac{1}{2}Z\,cr—PZ$. 37.475.	9.7842000
$s.\frac{1}{2}Z\,cr—FZ$. 30.495.	9.7054045
Square of the Sine of $\frac{1}{2}FZP$.	19.8428618
Sine of 57.94.	9.9214309

The double whereof is 115.88 the ☉ *Azimuth* from the North. And the Complement 64.12, is the ☉ *Azimuth* from the South.

PROBLEM 13.

To find the Point of the Ecliptick Culminating, and its Altitude.

Before we can know what Sign and Degree of the Ecliptick is in the *Medium Cœli*; we must find the Right Ascension thereof, to do which, we must add the Sun's Right Ascension to the time afternoon, being reduced into Degrees and Minutes of the *Æquator*, the Sum is the Right Ascension of the *Medium Cœli*.

Example. Let the time given, be *March* the 20. 1674. at one of the Clock in the Afternoon.

At which time the Sun's place is in ♈. 10 deg. 23 Centesms.

To find the Right Ascension thereof, in the Right angled Spherical Triangle ADF in *Fig.* 1. we have given; The Angle of the Sun's greatest Declination DAF 23.525 and the Sun's distance from the next Equinoctial Point AF 10.23.

Therefore by the ninth Case of Right angled Spherical Triangles.

As the *ct*. *AF*. 10. 23.	10.7435274
Is to *Radius*.	10.0000000
So is *cs* *D AF* 22. 525.	19.9623154
To *t AD* 9. 39.	9.2187180

To which adding the Equinoctial Degrees anſwering to one hour, *viz*. 15. the Sum is 24. 39 the Right Aſcenſion of the Mid Heaven. Hence to find the Point culminating; in the Right angled Spherical Triangle *ADF* in *Fig*. 1. we have given *AD* 24. 39 and *D AF* 23. 525 to find *AF*.

Therefore by the fifth Caſe of Right Angled Spherical Triangles.

As *t AD* 24. 39.	10.6564908
Is to *Radius*.	10.0000000
So is *cs D AF* 23. 525.	9.9623154
To *ct AF* 26. 31.	10.3058246

Therefore the Point culminating is ♈ 26. 31.

To find the Altitude thereof above the Horizon we have given in the ſame Triangle *D AF* 23. 525. and *AF* 26. 31. to find *DF*.

Therefore by the tenth Caſe of Right angled Spherical Triangles.

As *Radius*.	10.0000000
Is to *s AF*—26, 31.	9.6466268
So is *s D AF* 23. 525.	9.6011352
To the *s DF* 10. 19.	9.2477628

Which

Which is the North Declination of the Point of the Ecliptick culminating, and being added to the height of the *Æquator* at *London* 38,47 the Sum is 48.66 the Altitude of the Mid Heaven as was required.

PROBLEM 14.

Having the greatest obliquity of the Ecliptick together with the Distance of the Point given from the Equinoctial, to find the Meridian Angle, or Intersection of the Meridian with the Ecliptick.

Having drawn the Primitive Circle *HZRN* in *Fig.* 5. representing the Meridian, and the two Diameters *HAR*, and *ZAN*, set off the height of the Pole from *R* to *P*. 51.53, and from *N* to *S*, and draw the Diameters *PAS* for the *Axis* of the World, and *ÆAQ* for the *Æquator*; this done, the Right Ascension of the Mid Heaven being given, as in the last Problem 24.39 with the Point culminating. ♈. 26.31, and the Declination thereof 10.19, if you set 10 deg. 19 Centesmes from *Æ* to *F* and *e* to *X*, you may draw the Diameters *FAX* and *cAd* at Right Angles thereunto, and because the *Imum Cœli* is directly opposite to the Point culminating, that is, in ♎ 26.31, if you set 26.31 from *X* to *b*, a Ruler laid from *c* to *b* will cut the Diameter *FX* in *G*, and then making *XbZXb* you have the three Points *bGb*, by which to draw that Circle, which will cut the *Æquator* *ÆAQ* in ♎, and so you have the three Points *X*♎*F* by which to describe the Arch of the Ecliptick ♈*F*♎*X*.

And

And in the Right angled Spherical Triangle ♈ Æ F we have given. The Angle Æ ♈ F. 23. 525 the Sun's greatest Declination, and ♈ F. 26. 31. the Point culminating, to find the Angle ♈ F Æ.

Therefore by the seventh Case of Right angled Spherical Triangles.

As the *ct* Æ ♈ F. 23. 525.	10.3611802
Is to the *Radius*.	10.0000000
So is the *cs* ♈ F. 26. 31.	9.9525062
To the *cot.* ♈ F Æ. 68. 60.	9.5913260

Which is the Angle of the Ecliptick with the Meridian.

PROBLEM 15.

To find the Angle Orient, or Altitude of the Nonagesime Degree of the Ecliptick.

In *Fig.* 5. the Pole of the Ecliptick ♈ F ♎ X is at *m*, and so you have the three Points *Z m N* to draw the Vertical Circle *Z k N* cutting the Ecliptick at Right Angles in the Point *a*: And then in the Right angled Spherical Triangle *F a Z*, we have given; *F Z* 41. 34 the Complement of *F H* the Altitude of the Mid Heaven; And the Angle *a F Z* 68. 68 the Angle of the Ecliptick with the Meridian. To find *Z a*.

Therefore by the tenth Case of Right angled Spherical Triangles.

As

As the *Radius*.

To the Sine of *F Z*. 41. 34.	9.8198890
So is the Sine of *Z F a*. 68. 68.	9.9691128
To the Sine of *Z a*. 37. 97.	9.7891027

Whose Complement is *ak* the Measure of the Angle *agk* 52.03 the Angle of the Ecliptick with the Horizon, or Altitude of the Nonagesime Degree.

PROBLEM 16.

To find the place of Nonagesime Degree of the Ecliptick.

In *Fig*. 5. *F* represents the Point of the Ecliptick in the Mid Heaven, which according to Problem 14 is ♈. 26. 31 which being known, in the Triangle *F Z a*, we have also given, *F Z* 41. 34 and the Angle *Z F a*. 68. 68. To find *F a*.

Therefore by the ninth Case of Right angled Spherical Triangles.

As the *cot*. of *F Z*. 41. 34.	10.0556361
Is to the *Radius*.	10.0000000
So is the *cos*. of *Z F a*. 6. 8. 6. 8.	9.5605957
To the *tang*. of *F a*. 17. 73.	9.5049596

Which being added to ♈ *F* 26. 31 the sum is ♈ *a*. 44. 04 the place of the Nonagesime Degree of the Ecliptick at *a*.

PROBLEM 17.

PROBLEM 17.

The Mid Heaven being given, to find the Points of the Ecliptick Ascending and Descending.

Having found by the last Problem, the place of Nonagesime Degree of the Ecliptick at *a* to be in ♉. 14. 04, if you add 90 Degrees or three Signs thereto, the Ascendant at *g* will be in ♌ 14. 04, and the Point descending by adding of six Signs will be in ♒ 14. 02. But these with the Cusps of the other Houses of Heaven may be otherwise found in this manner.

To the Right Ascension of the *Medium Cœli* or the tenth House, add 30, it giveth the Ascension of the eleventh House, to which adding 90 Degrees more, it giveth the Ascension of the twelfth House, &c. According to which direction, the Ascensions of the six Houses towards the Orient, are here set down in the following Table.

10.	24.	39
11.	54.	39
12.	84.	39
1.	114.	39
2.	144.	39
3.	174.	39

Now because the Circles of Position must according to these Directions cut the *Æquator* at 30 and 30 Degrees above the Horizon, if in *Fig.* 5. you set 30 Degrees from *Æ* to *n*, and *n* to *r*. A Ruler laid from *P* to *n* and *r*, shall cut the *Æquator* at *B* and *K*, and then you may describe the Circles of Position *HBR* and *HKR*, make *AT* = *AK* and *AV* = *AB*, and so you may describe the Circles *HTR* and *HVR*, and where these Circles do cut the Arch

Arch of the Ecliptick ♈ *F* ♎ there are the Cusps of the Cœlestial Houses.

Thus a Ruler laid from *m.* the Pole of the Ecliptick to the Intersections & *s. t. g. y. v.* will cut the Primitive Circle in $\alpha . \gamma . \delta . \varepsilon . \eta .$ and the Arches $F\alpha = Fs .\ F\gamma = Ft .\ F\delta = Fg .\ F\varepsilon = Fy .$ and $F\eta = Fv$ being added to ♈ *B* will give you the Cusps of the 11. 12. 1. 2 and 3 Houses, the other six are the same Degrees and Parts in the Opposite Signs.

Thus a Figure in Heaven may be erected by Projection, the Arithmetical Computation now followeth; In which the height of the Pole above each Circle of Position is required, the which in the Projection is easily found; as the Pole of the Circle of Position *HBR* is at the Point *D.* and so you have the three Points *S, D, P,* to describe that Circle by, which will cut the Circle *HBR* at Right Angles in the Point *C.* and the Arch *PC* is the height of the Pole above that Circle of Position, and may be measured by the Directions given in the nineteenth of the third Chapter.

In like manner the height of the Pole above the Circle of Position *HKR*, will be the Arch *PE.*

To compute the same Arithmetically in the Right angled Spherical Triangle *H Æ B* in *Fig.* 5. we have given *Æ H.* 38. 47 the height of the *Equator.* *Æ B* 30. the difference of Ascension between the 10 and 11 Houses, to find *H B Æ* the Angle of that *Equator* with the Circle of Position.

Therefore by the first Case of Right angled Spherical Triangles.

As

As the Tang. of *H Æ*, 38.47.	9.90000652
Is to the *Radius*.	10.00000000
So is the Sine of *Æ B*. 30	9.69897000
To the Cotang. of *ÆBH*. 57.81626.	9.79888348

Whose Measure in the Scheme is *Æ C*, and the Complement thereof is *CP*. 32.18374 the height of the Pole required.

Therefore the height of the Pole above the Circle of Position *HKR*. In the Triangle *HÆK*, we have given, *HÆ* as before, and *ÆK*. 60 to find *HKÆ*. Therefore.

As the Tang. of *HÆ* 38.47.	9.90008652
Is to the *Radius*.	10.00000000
So is the Sine of *ÆK* 60.	9.93753063
To the Cotang. of *HKÆ* 42.53308.	10.03744411

Whose Measure in the Scheme is *G L*, and the Complement thereof is *P L* 47.46692. the height of the Pole required.

The height of the Pole above *H D R* is the same with *H B R*, and the height of the Pole above *H T R* is the same with *H K R*.

Having found the Ascensions of the several Houses together with the Elevation of the Pole above their Circles of Position, in the Oblique angled Spherical Triangle ♈ *B S*, we have given.

1. The Angle ♈ *B S* the Complement of *H B Æ*.

2. The Angle *B* ♈ *S*. 23. The Sun's greatest Declination.

3. Their included Side ♈ *B*. 54.39 the Ascension of the eleventh House. To find ♈ *S* the Point

Point of the Ecliptick, which is resolvable by the ninth Case of Right angled Spherical Triangles.

But in my *Trigonometria Britannica, Problem*, 5. for the resolving of Oblique angled Spherical Triangles, I have shewed how this Case as to our present purpose may be resolved, by these Proportions following.

1. $s\,\frac{1}{2}$ *Z* Ang. $s\,\frac{1}{2}$ *X* Ang : : $t\,\frac{1}{2}$ ♈ *B*. $t\,\frac{1}{2}$ *X* Cru.
2. $cs\,\frac{1}{2}$ *Z* Ang. $cs\,\frac{1}{2}$ *X* Ang : : $t\,\frac{1}{2}$ ♈ *B*. $t\,\frac{1}{2}$ *Z* Cru.

$\frac{1}{2}$ *Z* Cru + $\frac{1}{2}$ *X* Cru = ♈ *S* the Arch of the Ecliptick desired.

For the Cusp of the Eleventh House.

TB Arch ♈ *B*. 4439 the half whereof is 27.195.
♈ *BS*. 122. 18374.
B♈ *S*. 23. 525.

Z 145. 70874 — $\frac{1}{2}$ *Z* 72. 85437.
X. 198. 65874 — $\frac{1}{2}$ *X*. 49. 32937.

$s\,\frac{1}{2}$ *Z*. 72. 85437. *Comp. Arith.*	0. 01977589
$s\,\frac{1}{2}$ *X*. 49. 32937.	9. 88000800
$t\,\frac{1}{2}$ ♈ *B*. 27. 195.	9. 71081089
$t\,\frac{1}{2}$ *X* Cru. 22. 192.	9. 61059478

2. *Operation.*

$cs.\,\frac{1}{2}$ *Z*. 72. 85437. *Comp. Arith.*	0. 53012277
$ss\,\frac{1}{2}$ *X*. 49. 32937.	9. 81395860
$t\,\frac{1}{2}$ ♈ *B*. 27. 195.	9. 71081089
$t\,\frac{1}{2}$ *Z* Cru. 48. 611.	10. 05489226

1. Arch. 22. 192. Their Sum is 70. 803 the Point of the Ecliptick.

cs.

cs. ½ Z. 82. 51916. *Comp. Arith.* 0. 88517901
cs ½ X. 59. 00416. 9. 71164750
t. ½ ♈ A. 57. 195. 10. 19072348
t. ½ Z Cru: 78. 397. 10. 68754999
1. Arch — 53. 296. Their Sum 121. 693 is the Point of the Ecliptick for the Ascendant.

For the Cusp of the Second House.

In the Oblique angled Spherical Triangle ♈ T γ. we have given,

1. ♈ T. 144. 39. The half whereof is 72. 195.
2. ♈ T γ. 122. 18374 } To find ♈ γ. The An-
3. T γ y. 23. 525 } gles are the same with those of the Twelfth House. Therefore.

s. ½ Z. 80. 49596. *Comp. Arith.* 0. 00601663
s ½ X. 56. 97096. 9. 92351651

Their Sum 9. 92953314
t ½ ♈ T. 72. 195. 10. 49327695
t ½ X Cru. 69. 306. 10. 42281009

2. *Operation.*

cs ½ Z 80. 49596. *Comp. Arith.* 0. 78170174
cs ½ X 56. 97096. 9. 73628614

Their Sum 10. 51798788
t ½ ♈ T. 72. 195. 10. 49327695
t ½ Z Cru. 84. 34. 11. 01126483
1. Arch. 69. 306. Their Sum is 53. 740 is the Point of the Ecliptick for the Second House.

For

For the Cusp of the Third House.

In the Oblique angled Spherical Triangle ♈ ν θ, we have,

1. ♈ ν, 174. 39. The half whereof is 87. 195. The Angls ♈ ν θ and ν ♈ θ are the same with those of the Eleventh House.

$s\frac{1}{2}$ *Z*. 72. 85437.	*Comp. Arith.*	0.01977589
$s\frac{1}{2}$ ♈ 49. 32937.		9.88000800
Their Sum		9.89978389
$t\frac{1}{2}$ *X* ν. 87. 195.		11.30984054

For the Eleventh House.

For the Cusp of the Twelfth House.

In the Oblique angled Spherical Triangle ♈ *KF*, we have given.

1. ν *K*. 84. 39. The half whereof is. 42. 195.
2. ♈ *K t*. 137. 46692 } To find ♈ *t*.
3. *K* ♈ *t*. 23. 525 }

Z. 160. 99192	$\frac{1}{2}$ *Z*. 80. 49596
X. 113. 94192	$\frac{1}{2}$ *X*. 56. 97096

$s\frac{1}{2}$ *Z*. 80. 49596.	*Comp. Arith.*	0.00601663
$s\frac{1}{2}$ *X*. 56. 97096.		9.92351651
$t\frac{1}{2}$ ♈ *K*. 42. 195.		9.95740882
$t\frac{1}{2}$ *X* Cru. 37. 625.		9.88694196

2. *Operation.*

cs. $\frac{1}{2}$ *Z.* 80.49596.	*Comp. Arith.*	0.78170174
cs $\frac{1}{2}$ *X.* 56.97096.		9.73628614
t $\frac{1}{2}$ ♈ *K.* 42.195.		9.95740882
t $\frac{1}{2}$ *Z* Cru. 71.496.		10.47539670

1. Arch. 37.625. Their Sum 113.6691 is the Point of the Ecliptick for the Twelfth House.

For the Cusp of the Ascendant.

In the Oblique angled Spherical Triangle ♈ *AG* we have,

1. ♈ *A.* 114.39. The half whereof is 57.195.
2. ♈ *AZ.* 141.5333. The Complement of *HA Æ* 38.46667.
3. *A* ♈ *y.* 23.525.

Z.	165.05833	$\frac{1}{2}$ *Z.* 82.51916
X.	118.00833	$\frac{1}{2}$ *X.* 59.00416

s. $\frac{1}{2}$ *Z.* 82.51916.	*Comp. Arith.*	0.00371620
s. $\frac{1}{2}$ *X.* 59.00416.		9.93313477
t $\frac{1}{2}$ ♈ *A.* 57.195.		10.19072348
t $\frac{1}{2}$ *X.* 53.296.		10.12757454

2. *Operation.*

t $\frac{1}{2}$ *X* Cru. 86.468. 11.20962043

2. *Operation*

2. *Operation.*

cs $\frac{1}{2}$ *Z*. 72.85437.	*Comp. Arith.*	0.53012277
cs $\frac{1}{2}$ *X*. 49.32937.		9.81395860
Their Sum		10.34408137
t $\frac{1}{2}$ ♈ *v*. 87.195.		11.39984054
t $\frac{1}{2}$ *X* Cru. 88.729.		11.65392191

1. Arch. 86.468. Their Sum 175.197 is the Point of the Ecliptick for the Third House.

And thus we have not only erected a Figure for the Time given, but composed a Table for the general erecting of a Figure in that Latitude; for by adding together the first and second Numbers in each Proportion for the first, second and third Houses there is composed two Numbers for each House, to each of which the Artificial Tangent of half the Ascension of each House being added, their Aggregates are the Tangents of two Arches, which being added together, do give the distance of the Cusp of the House, from the first Point of *Aries*, as in the preceding Operations hath been shewed.

Only note, That if the Ascension of any House be more than a Semicircle, you must take the Tangent of half the Complement to a whole Circle. And to find the Cusp of the House, you must also take the Complement of the Sum of the Arches added together.

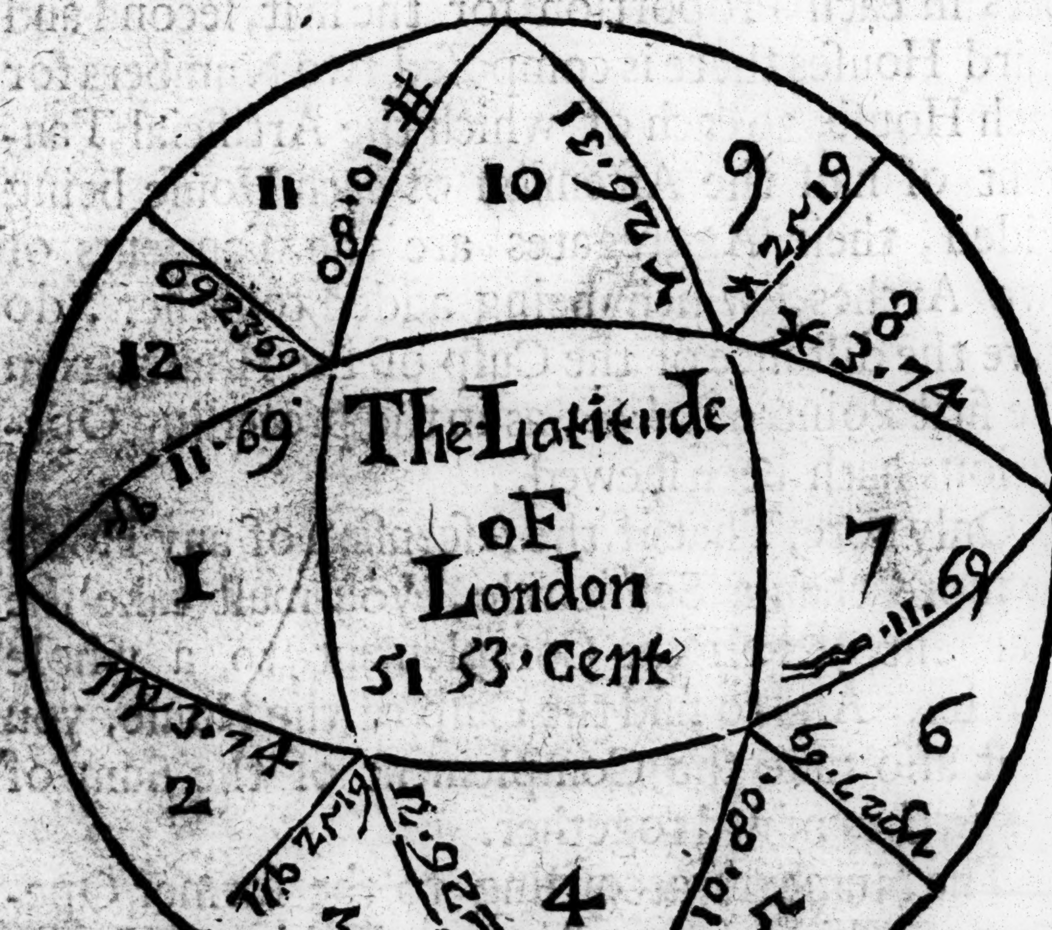
The Numbers according to the former Operations which do constitute a Table of Houses for the Latitude of *London*. 51.53 are as followeth.

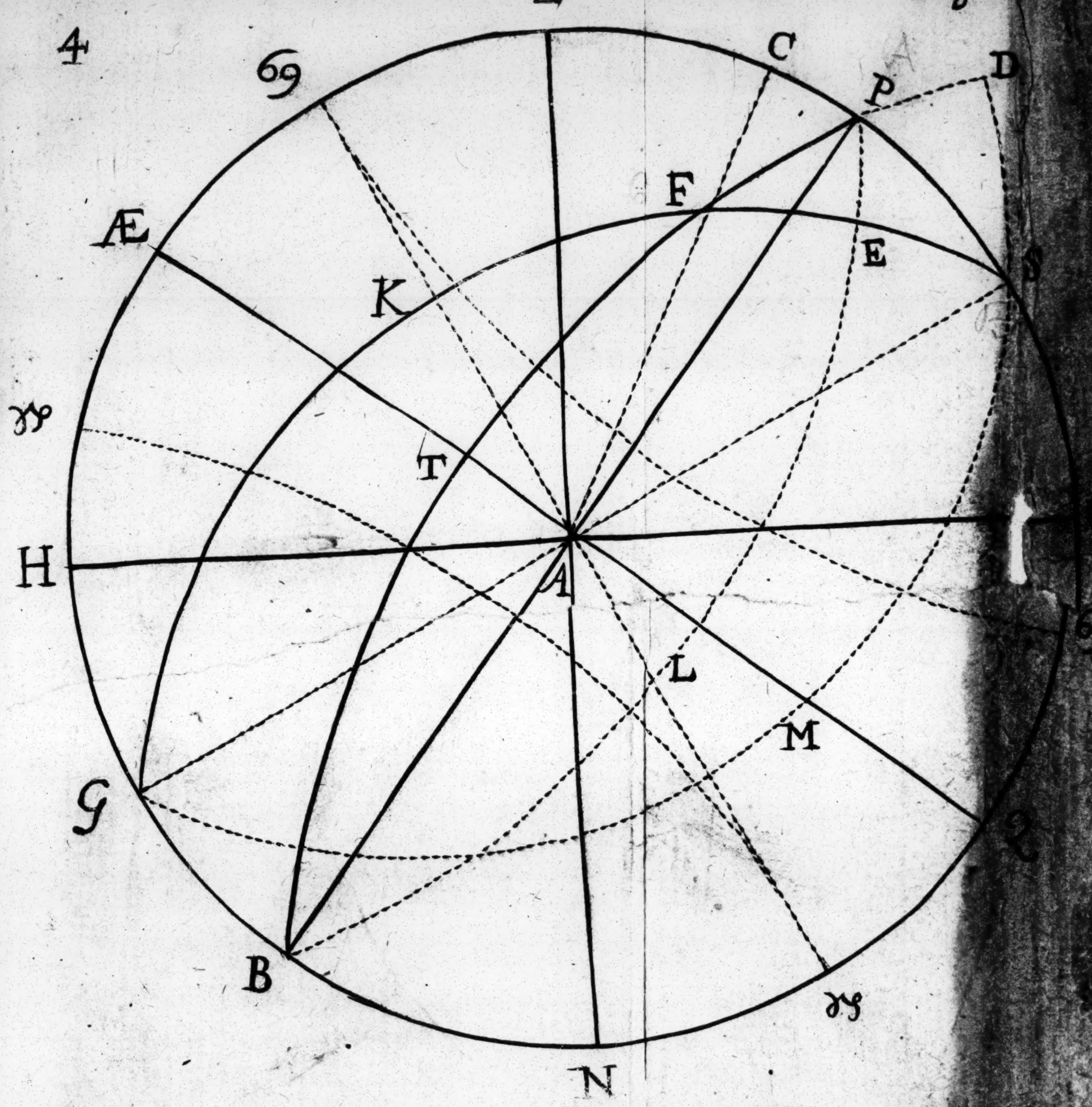
	11 and 3 Houses	Ascendant	12 and 2 Houses
1. Oper.	9.89978389	9.93685106	9.92953314
2. Oper.	10.34408137	10.59682651	10.51798788

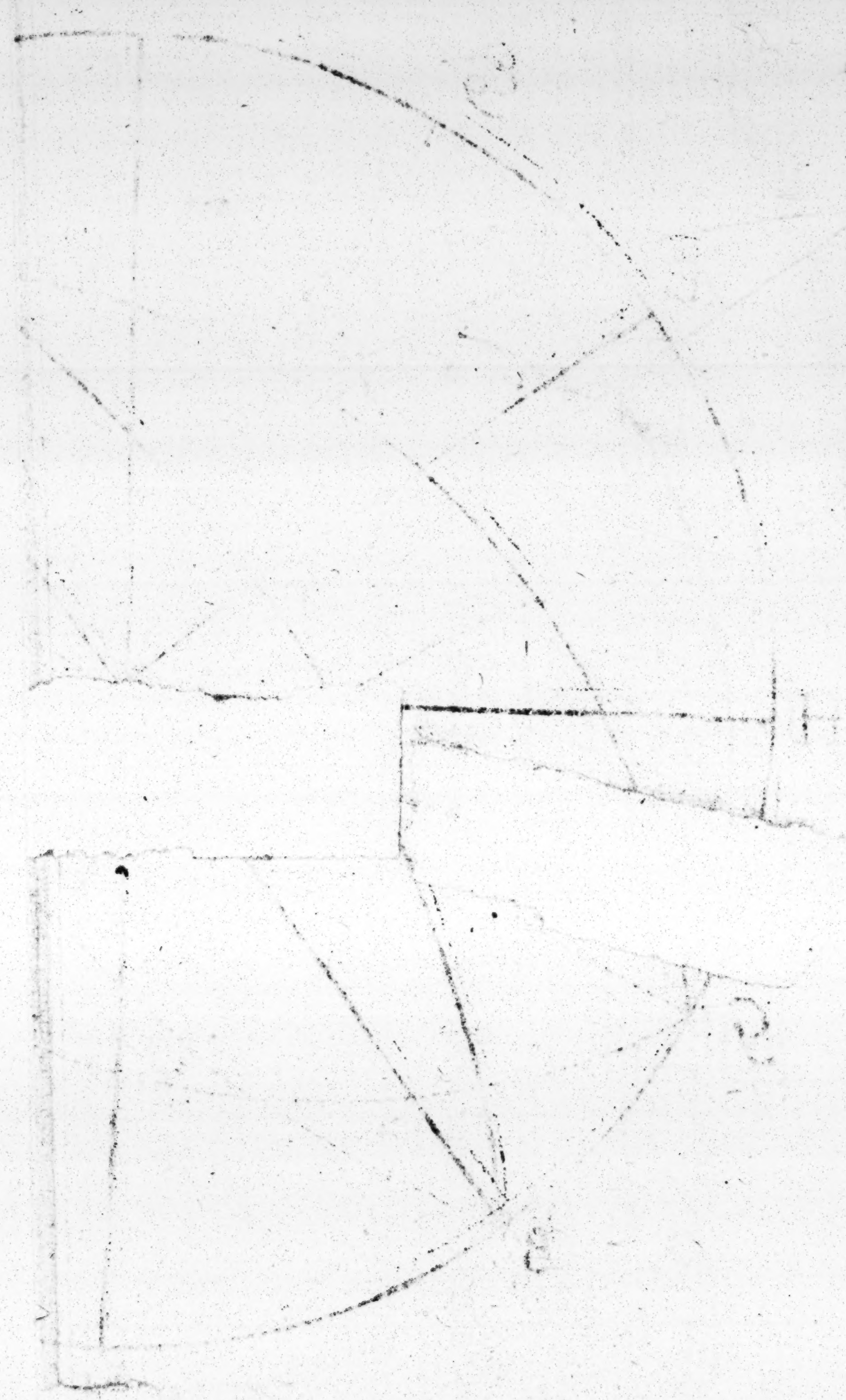
The Six Oriental Houses, by the preceding Operations.

10 House ♈ 26.311			4 House ♎ 26.311
11 House ♊ 10.803			5 House ♐ 10.803
12 House ♋ 23.691	*The opposite Houses are in the opposite Signs and Degrees.*		9 House ♑ 23.691
Ascendant ♌ 11.693			7 House ♒ 11.693
2 House ♍ 3.740			8 House ♓ 3.740
3 House ♏ 25.197			9 House ♓ 25.197

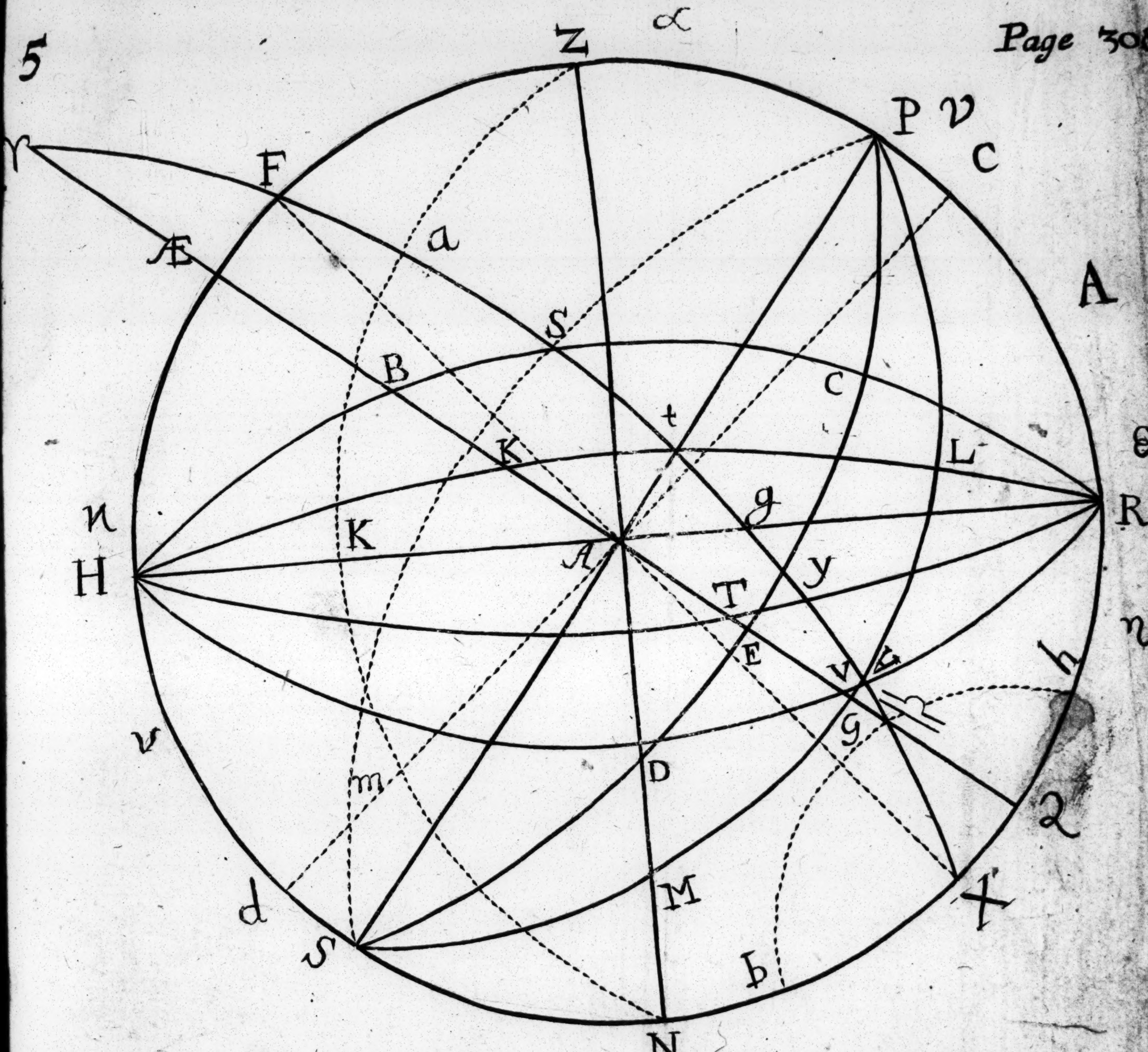
A Figure of the Twelve Cœlestial Houses.




Z
4
C
P
D
F
E
Æ
K
S
T
H
A
L
M
G
Q
B
N



5



ASTRONOMY.

THE

Ja. Buryes

Second Part:

OR,

AN ACCOUNT

OF THE

Civil Year,

With the Reason of the Difference

Between the

JULIAN & GREGORIAN

Calendars,

And the manner of Computing the Places of the *SUN* and *MOON*.

LONDON,

Printed for *Thomas Passinger*, at the *Three Bibles* on *London-Bridge*. 1679.

AN INTRODUCTION TO Astronomy.

The Second Book.

CHAP. I.

Of the Year Civil and Astronomical.

HAving shewed the Motion of the *Primum Mobile*, or Doctrine of the Sphere, which I call the Absolute Part of Astronomy; I come now unto the Comparative, that is, to shew the Motion of the Stars in reference to some certain Distinction of Time.

2. And the Distinction of Time is to be considered either according toNature, or according to Institution.

3. The Diſtinction of Time according to Nature, is that ſpace of Time, in which the Planets do finiſh their Periodical Revolutions from one certain Point in the Zodiack, to the ſame again, and this in reference to the Sun is called a Year, in reference to the Moon a Month.

4. The Sun doth paſs through the Zodiack in 365 Days, 5 Hours, and 49 Minutes. And the Moon doth finiſh her courſe in the Zodiack, and return into Conjunction with the Sun, in 29 Days, 12 hours, 44 Minutes, and 4 Seconds. And from the Motion of theſe two Planets, the Civil Year in every Nation doth receive its Inſtitution.

$29^{d}\ 12^{h}\ 44'.05305$
$29^{d}\ 12^{hr}\ 44'\ ''\ 11'''$

5. Twelve Moons or Moneths is the meaſure of the Common Year, in *Turkey* in every Moneth they have 29 or 30 Days, in the whole Year 354 Days, and in every third Year 355 Days.

6. The *Perſians* and *Egyptians* do alſo account 12 Moneths to their Year; but their moneths are proportioned to the Time of the Suns continuance in every of the Twelve Signs; in their Year therefore which is Solar, there are always 365 Days, that is eleven Days more than the Lunar Year.

7. And the *Julian* Year which is the Account of all Chriſtendom, doth differ from the other in this; that by reaſon of the Sun's Exceſs in Motion above 365 Days, which is 5 Hours, 49 Minutes, it hath a Day intercalated once in 4 Years, and by this intercalation, it is more agreeable to the Motion of the Sun, than the former, and yet there is a conſiderable difference between them, which hath occaſioned the Church of *Rome* to make ſome further amendment of the Solar

Year,

Year, but hath not brought it to that exactneſs, which might be wiſhed.

8. This intercalation of one Day once in 4 Years, doth occaſion the Sunday Letter ſtill to alter till 28 Years be gone about; The Days of the Week which uſe to be ſigned by the ſeven firſt Letters in the Alphabet, do not fall alike in every Common Year, but becauſe the Year conſiſteth of 52 Weeks and one Day, Sunday this Year will fall out upon the next Year's Monday, and ſo forward for ſeven years, but every fourth year conſiſting of 52 weeks and two days, doth occaſion the Sunday Letter to alter, till four times ſeven years, that is till 28 years be gone about. This Revolution is called the Cycle of the Sun, taking its name from the Sunday Letter, of which it ſheweth all the Changes that it can have by reaſon of the Biſſextile or Leap-year. To find which of the 28 the preſent is, add nine to the year of our Lord, (becauſe this Circle was ſo far gone about, at the time of Chriſts Birth) and divide the whole by 28, what remaineth is the preſent year, if nothing remain the Cycle is out, and that you muſt call the laſt year of the Cycle, or 28.

9. This Intercalation of one day in four years, doth occaſion the Letter *F* to be twice repeated in *February*, in which Moneth the day is added, that is, the Letter *F* is ſet to the 24 and 25 days of that Moneth, and in ſuch a year S. *Matthias* day is to be obſerved upon the 25 day, and the next Sunday doth change or alter his Letter, from which leaping or changing, ſuch a year is called Leap-year, aud the number of days in each Moneth is well expreſſed by theſe old Verſes.

Thirty

Thirty days hath September, April, June *and* November.
February *hath* 28 *alone, All the rest have thirty and one.*
But when of Leap-year cometh the Time,
Then days hath February *twenty and nine.*

That this year is ſomewhat too long, is acknowledged by the moſt skilful Aſtronomers, as for the number of days in a year the Emperours Mathematicians were in the right, for it is certain, that no year can conſiſt of more than 365 days, but for the odd hours it is as certain that they cannot be fewer than five, nor yet ſo many as ſix; ſo then the doubt is upon the minutes, 60 whereof do make an hour, a ſmall matter one would think, but how great in the conſequence we ſhall ſee. The Emperours year being more than 10 minutes greater than the Suns, will in 134 years riſe to one whole day, and by this means the Vernal or Spring Equinox, which in *Julius Cæſar*'s time was upon the 24 of *March*, is now in our time upon the 10 of *March*, 13 days backward, and ſomewhat more, and ſo if it be let alone will go back to the firſt of *March*, and firſt of *February*, and by degrees more and more backward ſtill.

10. To reform this difference, ſome of the late Roman Biſhops have earneſtly endeavoured. And the thing was brought to that perfection it now ſtandeth, by *Gregory* the Thirteenth, in the year 1582. His Mathematicians, whereof *Lilius* was the Chief, adviſed him thus: That conſidering there had been an Agitation in the

Council

Council of *Nice* ſomewhat concerned in this matter upon the motion of that Queſtion, about the Celebration of Eaſter. And that the Fathers of the Aſſembly, after due deliberation with the Aſtronomers of that time, had fixed the Vernal Equinox at the 21 of *March*, and conſidering alſo that ſince that time a difference of ten whole days had paſt over in the Calendar, that is, that the Vernal Equinox, which began upon the 21 of *March*, had prevented ſo much, as to begin in *Gregorie*'s days at the 10 of the ſame, they adviſed, that 10 days ſhould be cut off from the Calendar, which was done, and the 10 days taken out of *October* in the year 1582. as being the moneth of that year in which that Pope was born; ſo that when they came to the fifth of the moneth they reckoned the 15, and ſo the Equinox was come up to its place again, and happened upon the 21 of *March*, as at the Council of *Nice*.

But that *Lilius* ſhould bring back the beginning of the year to the time of the *Nicene* Council and no further, is to be marvelled at, he ſhould have brought it back to the Emperours own time, where the miſtake was firſt entered, and inſtead of 10, cut off 13 days; however this is the reaſon why theſe two Calendars differ the ſpace of 10 days from one another. And thus I have given you an account of the year as it now ſtands with us in *England*, and with the reſt of the Chriſtian World in reſpect of the Sun, ſome other particulars there are between us and them which do depend upon the motion of the Moon, as well as of the Sun, and for the better underderſtanding of them, I will alſo give you a brief account

account of her revolution. But first I will shew you, how the day of the moneth in any year propounded in one Couutry, may be reduced to its correspondent time in another.

11. Taking therefore the length of the year, to be in several Nations as hath been before declared, if we would find what day of the moneth in one Conntry is correspondent to the day of that moneth given in another , there must be some beginning to every one of these Accounts, and that beginning must be referred to some one, as to the common measure of the rest.

12. The most natural beginning of all Accounts, is the time of the Worlds Creation, but they who could not attain to the Worlds Beginning, have reckoned from their own, as the Romans from the building of *Rome*, the Greeks from their Olympicks , the Assyrians from *Nabonassar*, and all Christians from the Birth of Christ : the beginning of which and all other the most notable *Epochaes*, we have ascertained to their correspondent times in the Julian Period, which *Scaliger* contrived by the continual Multiplication of those Circles, all in former time of good use, and two of them do yet remain; the Circles yet in use are those of the Sun and Moon, the one, to wit, the Sun, is a Circle of 28 years, and the Circle of the Moon is 19, as shall be shewed hereafter. The third Circle which now serves for no other use than the constituting of the Julian Period , is the Roman Indiction , or a Circle of 15 years; if you multiply 28 the Circle of the Sun, by 19 the Circle of the Moon, the Product is 532, which being multiplied by 15, the Circle of the Roman Indiction, the Product is 7980, the

Number

Number of years in the Julian Period: whose admirable condition is to distinguish every year within the whole Circle by a several certain Character, the year of the Sun, Moon, and Indiction being never the same again until the revolution of 7980 years be gone about, the beginning of this Period was 764 Julian years before the most reputed time of the Worlds Creation; which being premised, we will now by Example shew you how to reduce the years of Forreigners to our Julian years, and the contrary.

1. *Example.*

I desire to know at what time in the Turkish Account, the fifth of *June* in the year of our Lord 1649. doth fall.

The Julian years complete are 1648, and are thus turned into days, by the Table of days in Julian years.

1000	Julian years give days	365250
600	Julian years give days	219150
40	Julian years give days	14610
8	Years give days	2922
	May complete	151
	Days	5
	The Sum is	602088

Now because the Turkish Account began *July* 16. *Anno Christi*. 622. you must convert these years into days also.

600	Julian years give days	219150
20	Years give days	7305
1	Year giveth days	365
	June complete	181
	Days	15
	The Sum is	227016
	Which being substracted from	602088
	There resteth days	375072
900	Turkish years give days	318930
	There resteth	56142
150	Turkish years give days	53155
	There resteth	02987
8	Turkish years give days	2835
	There resteth	152
	Giumadi. 4.	148
1058	4th Giumadi There resteth	4

Therefore the fifth of *June* 1649. in our English Account doth fall in the year 1058. of *Mahomet*, or the Turkish *Hegira*, the fourth day of the moneth *Giumadi*. 11.

2. *Example.*

I desire to know upon what day of our Julian year the 17 day of the moneth in the 1069 year complete of the Persian Account from *Jeshagile* doth fall.

The

The beginning of this *Epocha* is from the *Epocha* of Christ in complete days 230639

1000	Persian years give	365000
60	Years give	21900
9	Years give	3285
	Chortal complete	90
	Days complete	16
1069 years	The Sum	620930
1000	Julian years Substracted	365250
	There rests	255680
700	Julian years	255675
1700	There rests	5

Therefore it falls out in the Julian year from Christ 1700. the fifth day of *January*.

He that understands this may by the like method convert the years of other *Epochas*, into our Julian years and the contrary.

The Anticipation of the Gregorian Calendar is more easily obtained, for if you enter the Table with the years of Christ complete, you have the days to be added to the time in the Julian Account, to make it answer to the Gregorian, which will be but ten days difference till the year 1700. and then the differenee will be a day more, until the year 1800. and so forward three days difference more in every 400 years to come, unless our year shall be reformed as well as theirs.

CHAP. II.

CHAP. II.

Of the Cycle of the Moon, what it is, how placed in the Calendar, and to what purpose.

THat the Civil Year in uſe with us and all Chriſtians, doth conſiſt of 365 days, and every fourth year of 366, hath been already ſhewed, with the return of the Sunday Letter in 28 years. In which time the Moon doth finiſh her courſe in the Zodiack no leſs than twelve times, which twelve Moons, or 354 days, do fall ſhort of the Sun's year, eleven days in every common year, and twelve in the Biſſextile or Leap-year.

And by Obſervation of *Meton* an *Athenian*, it was found out about 432 years before Chriſt, that the Moon in nineteen years did return to be in Conjunction with the Sun on the ſelf ſame day, and this Circle of nineteen years is called the Cycle of the Moon, which being written in the Calendar againſt the day in every Month, in which the Moon did change, in Letters of Gold, was alſo called the Golden Number, or from the excellent uſe thereof, which was at firſt, only to find the New Moons in every Month for ever, but amongſt Chriſtians it ſerveth for another purpoſe alſo, even the finding of the time when the Feaſt of Eaſter is to be obſerved. The New Moons by this Number are thus found. In the firſt year of the Circle, or when the Golden Number is 1, where the Number 1 was ſet in the Calendar in any Moneth, that day is New Moon, in the

the second Year where you find the golden Number 2, in the third Year where you find the golden Number 3, and so forward till the whole Circle be expired; then you must begin with one again, and run through the whole Circle as before.

2. And the reason why the Calendar begins with the golden Number 3, not 1, is this. The Christians in *Alexandria* had used this Circle of the Moon two Years before the Nicene Council. And in the first of these Years the new Moon next to the Vernal Equinox was upon the 27th Day of the Egyptian month *Phamenoth* answering to the 23d of our *March*, against that Day therefore they placed the golden Number 1. And because there are 29 Days and a half from one new Moon to another, they made the distance between the new Moons to be interchangeably 29 and 30 Days, and so they placed the same golden Number against the 26 Day of *Phurmuthi* the Month following, and against the 26 Day of the Month *Pachon* and so forward, and upon this ground by the like progression was the golden Number set in the Roman Calendar; and so the golden Number 1 by their example was set against *March* 23. *April* 21. *June* 19. *July* 19. *August* 17. *September* 16. *October* 15. *November* 14. *December*. 13. But then because in the following Year the golden Number was 2. reckoning 30 Days from the 13th of *December*, the golden Number 2 was set to *January* 12. *February* 10. *March* 12. *April* 10. *May* 10. *June* 8. *July* 8. *August* 6. *September* 5. *October* 4. *November* 3. *December*. 2. From whence reckoning 13 Days as before, the golden Number 3

comes in course for the third Year to be set against the first of *January*.

But that you may know how the golden Number comes to be distributed in the Calendar according to the form in which it now is, you must consider that in 19 Solar Years there are not only 228 Lunar Months or 12 times 19 Lunar Months but 235 for the 11 Days which the common Solar Year doth exceed the Lunar, do in 19 Years arise to 209 Days, out of which there may be appointed 7 Months, 6 whereof will contain 30 Days apiece, and one Month 29 days; and these 7 Months are called Embolismical Months, because by a kind of injection or interposition they are reckoned in some of the 19 Years. And those Years in which they are reckoned are called Embolismical Years, to distinguish them from the common Years which always contain 354 Days, whereas 6 of these Embolismical Years do each of them contain 384 Days, and the seventh Embolismical Year in which the Month of 29 Days is reckoned, doth contain 383 Days.

3. The Embolismical Years in the Cycle of the Moon are properly these Seven. 3, 6, 9, 11, 14, 17, 19. because in the third Year 11 Days being thrice reckoned do amount to 33 Days, that is one Month of 30 Days and 3 Days over. Again in the sixth Year the 11 Days which the Solar exceed the Lunar, being thrice numbred, do amount to 33 Days. which with the 3 Days formerly reserved do make 36 Days, that is one Month of 30 Days and 6 Days over. Again in the Ninth Year there are also 33 Days, to which the 6 Days reserved being added, there will arise one Month more and 9 Days over. But in the

the Eleventh Year twice 11 Days being added to the 9 Days reserved, do make 31 Days, that is, one Month of 30 days and one day over, which being added to the supernumerary days in the fourteenth Year do make another Month of 30 Days and 4 Days over, and these being added to the supernumerary Days in the seventeenth Year do make another Month of 30 and 7 Days over, and these 7 Days being added to the 22 supernumerary Days in the Ninteenth Year of the Moons Cycle do make another Month of 29 Days.

4. But because there are 6939 Days and 18 Hours in 19 Solar Years, that is, 4 Days 18 Hours more then in the common and Embolismical Lunar Years, in which the excess between the Lunar and the Solar Year is supposed to be no more then 11 Days in each Year, whereas in every fourth Year the excess is one Day more, that is, 12 Days, that is, in 16 Years 4 Days, and in the remaining 3 Years three fourths of a day more. And that the new Moons after 19 Lunar Years or 235 Lunations do not return to the same days again, but want almost 5 days, it is evident that the civil Lunations do not agree with the Astronomical and that there must be yet some kind of intercalation used.

5. Now therefore in distributing the golden Number throughout the Calendar. If the new Moons should interchangeably consist of 30 and 29 days, and so but 228 Lunations in 19 Years, we might proceed in the same order in which we have begun, and by which as hath been shewed the third Year of the Golden Number falls upon the Calends of *January*. But for as much as there are first six Lunations of 30 days apiece and

one of 29 days to be interpoſed, therefore there muſt be 6 times 2 Lunations together conſiſting of 30 days and once three Lunations of 29 days. And that reſpect may be alſo had to the Biſſextile days, although they are not expreſt in the Calendar, that Lunation which doth contain the Biſſertile day, if it ſhould have been 29 days, it muſt be 30, if it ſhould have conſiſted of 30 days it muſt conſiſt of 31.

6. And becauſe it was thought convenient, as hath been ſhewed, to begin with the third Year of the Cycle of the Moon, becauſe the Golden Number 3 is ſet to the Calends of *January*, therefore in this Cycle the Emboliſmical Years are, 2, 5, 8, 11, 13, 16, 19. But yet that it may appear, that theſe Years are in effect the ſame, as if we had begun with the firſt Year of the Golden Number, ſave only that the eighth Year inſtead of the ninth is to be accounted Emboliſmical, I have added the Table follwing, in which it is apparent that the former Emboliſmical years do agree with theſe laſt mentioned.

7. But as I ſaid before, it was thought more convenient to begin the account from the number 3 ſet to the Calends of *January*, becauſe by ſo reckoning 30 and 29 days to each Lunation interchangeably, the ſame Number 3 falls upon *January* 31. *March* 1, and 31. *April* 29. *May* 29. *June* 27. *July* 27. *Auguſt* 25. *September* 14. *October* 23. *November* 22. *December* 21. As if the Lunar years were compleated upon the 20 of *December* there remain juſt 11 Days, which the Solar years doth exceed the Lunar.

8. And by ranking on and accounting 4 for the Golden Number of the next year, you will

find

find it set on *January* 20, *February* 18, *March* 20, *April* 18, *May* 18, *June* 16, *July* 16, *August* 14, *September* 13, *Octob.* 12, *Novemb.* 11, *Decemb.* 10.

9. But in going on, and taking 5 for the Golden Number in the third year, we must remember that that is an Embolismical Year, and therefore that some-where there must be 2 Months together of 30 days. And for this reason the Golden Number 5, is set to *January* 9, *February* 7, *March* 9, *April* 7, *May* 7, *June* 5, *July* 5, *August* 3, *September* 2, as also upon the second day of *October*, and not upon the first, that so there may be 2 Lunations together of 30, and the same Number 5 is also set to the thirty first of *October*, to make the Lunation to consist of 29 days, and to the thirtieth of *November* instead of the twenty ninth, that so a Lunation of

Cycle of the Moon.	Cycle of the Moon.	Embolismical Years.	Number of Days.
1	3		354
2	4		354
3	5	Embol.	384
4	6		354
5	7		354
6	8	Embol.	384
7	9		354
8	10		354
9	11	Embol.	384
10	12		354
11	13	Embol.	384
12	14		354
13	15		354
14	16	Embol.	384
15	17		354
16	18		354
17	19	Embol.	384
18	1		354
19	2	Embol.	384

30 may again succeed as it ought.

10. In like manner in the sixth Year, having gone through the fourth and fifth as common years, you may see the Golden Number 8 set to the fifth of *April*, which should have been upon the fourth, and in the ninth Year the Golden Number 11 is set to the second of *February* which should have been upon the first.

And there is a particular reason, for which these numbers are otherwise placed from the eighth of *March* to the fifth of *April*, namely, that all the paschal Lunations may consist of 29 days: For thus from the eighth of *March* to the sixth of *April*, to both which days the Golden Number is 16, there are but 29 days. And from the ninth of *March* to the seventh of *April*, to both which days the Golden Number is 5, there are also 29 days, and so of the rest till you come to the fifth of *April*, which is the last Paschal Lunation, as the eighth of *March* is the first, but at any other time of the Year, the length of the Month in the Embolismical Year, may be fixed as you please.

12. And in this manner in the 17 years, in which the lunations of the whole Circle are finished, and in which the Golden Number is 19, the Month of *July* is taken at pleasure, to the thirtieth day whereof is set the Golden Number 19, which should have been upon the thirty first, and the same Number being notwithstanding placed upon the twenty eighth of *August*, that by the two Lunations of 29 days together, it might be understood, that the seventh Embolismical Month consisting of 29 days is there inserted, instead of a Month of 30 days. In which place the Embolismical or leaping Year of the Moon may plainly

plainly be observed for that year is one day less than the rest, which the Moon doth as it were pass over. The which one day is again added to the 29 days of the last Month, that we may by that means come, as in other Years, to the Golden Number, which sheweth the New Moon in *January* following. And for this reason the Epact then doth not consist of 11 but of 12 days. And thus you see the reason, for which the Golden Numbers are thus set in the Calendar as here you see. In which we may also observe, that every following Number is made by adding 8 to the Number preceding, and every preceding Number is also made by adding 11 to the Number next following, and casting away 19 when the addition shall exceed it.

For Example, if you add 8 to the Golden Number 3 set against the first of *January*, it maketh 11, to which add 8 more and it maketh 19, to which adding 8 it maketh 27, from which substracting 19 the remainer is 8, to which again adding 8, the sum is 19, to which adding 8 the sum is 24, from which deducting 19 the remainer is 5, and so of the rest. In like manner receding backward, to the 5 add 11 they make 16, to the 16 add 11 they make 27, from which deducting 19 the remainer is 8, to which 11 being added the same is 19, to which 11 being added the sum is 30, from which deducting 19 the remainer is 11, to which 11 being added the sum is 22, from which deducting 19 the remainer is 3. And by this we may see that every following number will be in use 8 years after the preceding, and every preceding Number will be in use 11 years after the following, that is, the same will return to be in use after

8 Years and 11, and the other after 11 Years and 8, or once in 19 years.

CHAP. III.

Of the Use of the Golden Number in finding the Feast of Easter.

THE Cycle of the Moon or Golden Number is a circle of 19 years, as hath been said already, which being distributed in the Calendar as hath been shewn in the last Chapter, doth shew the day of the New Moon for ever; though not exactly: But the use for which it was chiefly intended, was to find the Paschal New Moons, that is, those new Moons on which the Feast of *Easter* and other moveable Feasts depend. To this purpose we must remember,

1. That the vernal Equinox is supposed to be fixed to the twenty first day of *March*.

2. That the fourteenth day of the Moon on which the Feast of *Easter* doth depend, can never happen before the Equinox; though it may fall upon it or upon the day following.

3. That the Feast of *Easter* is never observed upon the fourteenth day of the Moon, but upon the Sunday following; so that if the fourteenth day of the Moon be Sunday, the Sunday following is Easter day.

4. That the Feast of *Easter* may fall upon the fifteenth day of the Moon, or upon any other day unto the twenty first, inclusively.

5. That the Paschal Sunday is discovered by the

the proper and Dominical Letter for every Year The which may be found as hath been already declared, or by the proper Table for that purpoſe. Hence it followeth,

1. That the New Moon immediately preceding the Feaſt of *Eaſter*, cannot be before the eighth day of *March*, for if you ſuppoſe it to be upon *March* 6, the Moon will be 14 days old *March* 19, which is before the Equinox, contrary to the ſecond Rule before given, and upon the ſeventh day of *March* there is no Golden Number fixed; and therefore the Golden Number 16, which ſtandeth againſt *March* 8, is the firſt by which the Paſchal New Moon may be diſcovered.

2. It followeth hence, That the laſt Paſchal New Moon cannot happen beyond the fifth day of *April*, becauſe all the 19 Golden Numbers are expreſſed from the eighth of *March* to that day. And if a New Moon ſhould happen upon the ſixth of *April*, there would be two Paſchal New Moons that year, one upon the eighth of *March* and another upon the ſixth of *April*, the ſame Golden Number 16 being proper to them both, but this is abſurd becauſe *Eaſter* cannot be obſerved twice in one year.

3. It followeth hence, That the Feaſt of *Eaſter* can never happen before the twenty ſecond day of *March*, nor after the twenty fifth day of *April*: For if the firſt New Moon be upon the eighth of *March*, and that the Feaſt of *Eaſter* muſt be upon the Sunday following the fourteenth day of the Moon; it is plain that the fourteenth day of the Moon muſt be *March* 21 at the ſooneſt: So that ſuppoſing the next day to be Sunday, *Eaſter* cannot

not be before *March* the twenty second. And because the fourteenth day of the last Moon falleth upon the eighteenth day of *April*, if that day be Saturday, and the Dominical Letter *D*, *Easter* shall be upon the nineteenth day, but if it be Sunday, *Easter* cannot be till the twenty fifth.

4. It followeth hence, That although there are but 19 days, on which the fourteenth day of the Moon can happen, as there are but 19 Golden Numbers, yet there are 35 days from the twenty second of *March* to the twenty fifth of *April*, on which the Feast of *Easter* may happen, because there is no day within those Limits, but may be the Sunday following the fourteenth day of the Moon. And although the Feast of *Easter* can never happen upon *March* 22, but when the fourteenth day of the Moon is upon the twenty first, and the Sunday Letter *D*, nor upon the twenty fifth of *April*, but when the fourteenth day of the Moon is upon *April* 18, and the Dominical Letter *C*. Yet *Easter* may fall upon *March* 23, not only when the fourteenth day of the Moon is upon the twenty second day which is Saturday, but also if it fall upon the twenty first which is Friday. In like manner *Easter* may fall upon *April* 24, not only when the fourteenth day of the Moon is upon the eighteenth day which is Monday, but also if it happen upon the seventeenth being Sunday. And for the same reason it may fall oftner upon other days that are further distant from the said twenty second of *March* and twenty fifth of *April*.

5. It followeth hence, That the Feast of *Easter* may be easily found in any Year propounded: For the Golden Number in any Year being given, if you

you look the ſame between the eighth of March and fifth of *April* both incluſively, and reckon 14 days from that day, which anſwereth to the Golden Number given, where your account doth end is the fourteenth day of the Moon: Then conſider which is the Dominical Letter for that Year, and that which followeth next after the fourteenth day of the Moon is Eaſter day. Example, In the year 1674 the Golden Number is 3, and the Sunday Letter *D*, which being ſought in the Calendar between the aforeſaid limits, the fourteenth day of the Moon is upon *April* the thirteenth, and the *D* next following is *April* 19. And therefore *Eaſter* day that Year is *April* 19. Otherwiſe thus.

In March *after the firſt* C,
Look the Prime wherever it be,
The third Sunday after Eaſter *day ſhall be.*
And if the Prime on Sunday be,
Reckon that for one of the Three.

6. Thus the Feaſt of *Eaſter* may be found in the Calendar, and from thence a brief Table ſhewing the ſame, may be extracted in this manner. Write in one Column the ſeveral Golden Numbers in the Calendar from the eighth of *March* to the fifth of *April*, in the ſame order obſerving the ſame diſtance. In the ſecond Column ſet the Dominical Letters in number 35 ſo diſpoſed, as that no Dominical Letter may ſtand againſt the Golden Number 16, but ſetting the Letter *D* againſt the Golden Number 5, write the reſt in this

this order. *E*, *F*, *G*, *A*, *B*, *&c.* and when you come to the Golden Number 8, ſet the Letter *C*, and there continue the Letters till you come to *C* again, becauſe when the Golden Number is 16, which in the Calendar is ſet to the eighth day of *March*, is new Moon, and the fourteenth day of that Moon doth fall upon the twenty firſt, to which the Dominical Letter is *C*, upon which the Feaſt of *Eaſter* cannot happen; and therefore in the third Column containing the day in which the Feaſt of *Eaſter* is to be obſerved, is alſo void. But in the next place immediately following, to wit, againſt the letter *D* is ſet *March* 22, becauſe if the fourteenth day of the Moon ſhall fall upon the twenty firſt of *March* being Saturday, the next day being Sunday, ſhall be the Feaſt of *Eaſter*.

To the Letters following, *E*, *F*, *G*, *A*, *B*, *&c.* are ſet 23, 24, 25, and ſo orderly to the laſt of *March*, and ſo forward till you come to the twenty fifth of *April*, by which Table thus made, the Feaſt of *Eaſter* may be found until the Calendar ſhall be reformed.

For having found the Golden Number in the firſt Column, the Dominical Letter for the Year next after it, doth ſhew the Feaſt of *Eaſter*, as in the former Example, the Golden Number is 3 and the Dominical Letter *D*, therefore *Eaſter* day is upon *April* 19. The other moveable Feaſts are thus found.

Advent Sunday is always the neareſt Sunday to St. *Andrews*, whether before or after.

Septua-

Septuagesima Sunday is Nine Weeks before *Easter*.

Sexagesima Sunday is Eight Weeks before *Easter*.

Qainquagesima Sunday is Seven Weeks before *Easter*.

Quadragesima Sunday is Six Weeks before *Easter*.

Rogation Sunday is five Weeks after *Easter*.

Ascension day is Forty Days after *Easter*.

Whitsunday is Seven Weeks after *Easter*.

Trinity Sunday is Eight Weeks after *Easter*.

G. N.	D. L.	Easter.
XVI		
V	D	22 March
	E	23
XIII	F	24
II	G	25
	A	26
X	B	27
	C	28
XVIII	D	29
VII	E	30
	F	31
XV	G	1 April
IV	A	2
	B	3
XII	C	4
I	D	5
	E	6
IX	F	7
	G	8
XVII	A	9
VI	B	10
	C	11
XIV	D	12
III	E	13
	F	14
XI	G	15
	A	16
XIX	B	17
VIII	C	18
	D	19
	E	20
	F	21
	G	22
	A	23
	B	24
	C	25

CHAP.

CHAP. IV.

Of the Reformation of the Calendar by Pope Gregory *the Thirteenth; and substituting a Cycle of Epacts in the room of the Golden Number.*

Hitherto we have spoken of the Calendar which is in use with us, we will now shew you for what reasons it is alter'd in the Church of *Rome*, and how the Feast of *Easter* is by them observed.

The Year by the appointment of *Julius Cæsar* consisting of 365 days 6 hours, whereas the Sun doth finish his course in the Zodiack, in 365 days 5 hours 49 minutes or thereabouts, it cometh to pass that in 134 Years or less, there is a whole day in the Calendar more than there ought; in 268 years 2 days more; in 402 years 3 days: and so since *Julius Cæsar*'s time the vernal Equinox hath gone backward 13 or 14 days, namely from the 24 of *March* to the tenth. Now because the Equinox was at the time of the *Nicene* Council upon the twenty first of *March*, when the time for the observing of *Easter* was first universally established, they thought it sufficient to bring the Equinox back to that time, by cutting off 10 days in the Calendar as hath been declared, and to prevent any anticipation for the time to come, have appointed, that the Leap-year shall be thrice omitted in every 400 Years to come, and for memory sake, appointed the first omission to be accounted from the Year 1600, not from 1582, in which the reformation was made, because it was not only near the time, in which the emendation was begun, but also because the Equinox has not fully made an anticipation of 10 days from the place

place thereof, at the time of the *Nicene* Council, which was *March* 21.

The Years then 1700, 1800, 1900, which should have been Bissextile Years, are to be accounted common years, but the Year 2000 must be a Bissextile: In like manner the Years 2100, 2200, 2300, shall be common years, and the Year 2400 Bissextile, and so forward.

2. Again, because it was supposed that the Cycle of the Moon, or Golden Number was so fixed, that the new and full Moons would in every 19 years return to the same days again; whereas their not returning the same hours, but making an anticipation of one hour 27 minutes or thereabouts, it must needs be that in 17 Cycles or little more than 300 Years, there would be an anticipation of a whole day. And hence it is evident that in 1300 Years since the *Nicene* Council, the New and Full Moons do happen more than 4 days sooner than the Cycle of the Moon or Golden Number doth demonstrate: Whence also it comes to pass, that the fourteenth day of the Moon by the Cycle is in truth the eighteenth day, and so the Feast of *Easter* should be observed not from the fifteenth day of the Moon to the twenty first, but from the nineteenth to the twenty fifth.

3. That the Moon therefore being once brought into order, might not make any anticipation for the time to come, it is appointed that a Cycle of 30 Epacts should be placed in the Calendar instead of the Golden Number, answering to every day in the Year; to shew the New Moons in these days, not only for 300 Years or thereabouts, but that there might be new Epacts without

out altering the Calendar, to perform the same thing upon other days as need shall require.

4. For the better understanding whereof, to the Calendar in use with us, we have annexed the Gregorian Calendar also: In the first Column whereof you have 30 numbers from 1 to 30, save only that in the place of 30 you have this Asterisk *, But they begin with the Calends of *January*, and we continued and repeated after a Retrograde order in this manner, *29, 28, 27, *&c.* and that for this cause especially, that the number being given which sheweth the New Moons in every Month for one Year, you might by numbring 11 upwards exclusively find the number which will shew the New Moons the Year following, to wit, the Number which falleth in the eleventh place.

5. And these Numbers are called Epacts, because they do in order shew those 11 days, which are yearly to be added to the Lunar Year consisting of 354 days, that it may be in conformity with the Solar Year consisting of 365 days. To this purpose, as hath been said concerning the Golden Number, these Epacts being repeated 12 times, and ending upon the twentieth day of *December*, the same Numbers must be added to the 11 remaining days, which were added to the first 11 days in the Month of *January*.

6. And because 12 times 30 do make 360, whereas from the first of *January* to the twentieth of *December* inclusively, there are but 354 days, you must know that to gain the other six days, the numbers 25 and 24 are in every other Month both placed against one day, namely, to *February* 5, *April* 5, *June* 3, *August* 1, *September* 29, and *Novem-*

November 27. But why theſe two Numbers are choſen rather then any other, and why in theſe 6 Months the number 25 is ſometimes writ to XVI, ſometimes to XXV in a common character, and why the number 19 is ſet to the laſt day of *December* in a common Character, ſhall be declared hereafter.

7. Here only note that this Aſterisk * is ſet inſtead of the Epact 30, becauſe the Epact ſhewing the Number of days which do remain after the Lunation in the Month of *December*, it may ſometimes fall out that 2 Lunations may ſo end, that the one may require 30 for the Epact, and the other 0, which would, if both were written, cauſe ſome inconveniences, and therefore this * Aſterisk is there ſet, that it might indifferently ſerve to both. And the Epact 29 is therefore ſet to the ſecond day of *January*, becauſe after the compleat Lunation in the ſecond of *December* there are 29 days, and for the like reaſon the Epact 28 is ſet againſt the third of *January*, becauſe after the compleat Lunation in the third of *December* there are then 28 days over, and ſo the reſt in order till you come to the thirtieth of *January*, where you find the Epact 1. becauſe after the compleat Lunation on the thirtieth day there is only one day over.

8. And beſides the ſhewing of the New Moons in every Month, which is and may be done by the Golden Number, the Epacts have this advantage, that they may be perpetual and keep the ſame place in the Calendar in all future ages, which can hardly be effected with the Golden Number, for in little more then 700 years, the New Moons do make an anticipation of one day, and then it

will be necessary to set the Golden Number one degree backward, and so the Golden Number which at the time of the Nicene Council was set to the first of *January*, should in 300 years be set to the last of *December*, and so of the rest, but the Epacts being once fixed shall not need any such retraction or commutation. For as often as the New Moons do change their day either by Anticipation or by Suppression of the Bissextile year, you shall not need to do any more than to take another rank of 19 Epacts, insteed of those which were before in use. For instance, the Epacts which are and have been in use in the Church of *Rome* since the year of reformation 1582, and will continue till the year 1700, are these 10 following 1. 12. 23. 4. 15. 26. 7. 18. 29. 10. 21. 2. 13. 24. 5. 16. 27. 8. 19. And from the year 1700 the Epacts which will be in use are these. * 11. 22. 3. 14. 25. 6. 17. 28. 9. 20. 1. 12. 23. 4. 15. 26. 7. 18. and shall continue not only to the year 1800, but from thence until the year 1900 also; and although in the year 1800 the Bissextile is to be suppressed, yet is there a compensation for that Suppression, by the Moons Anticipation. To make this a little more plain, the motion of the Moon, which doth occasion the change of the Epact, must be more fully considered.

CHAP. V.

CHAP. V.

Of the Moons mean Motion, and how the Anticipation of the New Moons may be discovered by the Epacts.

THe Moon according to her middle motion doth finish her course in the Zodiack in 29 days, 12 hours 44 minutes, three seconds or thereabout, and therefore a common Lunar year doth consist of 354 days, 8 hours, 48 minutes, 38 seconds and some few thirds, but an Embolismical year doth consist of 383 days, 21 hours, 32 minutes, 41 seconds and somewhat more; and therefore in 19 years it doth exceed the motion of the Sun 1 hour, 27 minutes, 33 seconds *ferè*. 29d 12h 44' 03"

2. Hence it cometh to pass, that although the New Moons do after 19 years return to the same days; yet is there an Anticipation of 1 hour, 27 minutes, 33 seconds. And in twice 19 years, that is, in 38 years, there is an Anticipation of 2 hours, 55 minutes, 6 seconds, and after 312 years and a half, there is an Anticipation of one whole day and some few Minutes. And therefore after 312 years no new Moon can happen upon the same day it did 19 years before, but a day sooner. Hence it comes to pass that in the Julian Calendar, in which no regard is had to this Anticipation, the New Moons found out by the Golden Number must needs be erroneous, and from the time of the Nicene Council 4 days after the New Moons by a regular Computation.

3. And hence it follows also, that if the Golden Number, after 312 were upon due considera-

ration removed a day forwarder or nearer the beginning of the Months, they would ſhew the New Moons for 312 years to come. And being again removed after thoſe years, a day more would by the like reaſon do the ſame again. But it was thought more convenient ſo to diſpoſe 30 Epacts, that they keeping their conſtant places, 19 of them ſhould perform the work of the Golden Number, until by this means there ſhould be an Anticipation of one day. And when ſuch an Anticipation ſhould happen, thoſe 19 Epacts being let alone, other 19 ſhould be uſed, which do belong to the preceding day, without making any alteration in the Calendar.

4. And if this Anticipation would do the whole work, nothing were more plain, then to make that commutation of the 19 Epact once in 312 years: but becauſe the detraction of the Biſſextile days doth variouſly interpoſe and cauſe the 19 Epacts ſometimes to be changed into theſe that do precede, ſometimes into theſe that follow, ſometimes into neither, but to continue ſtill the ſame; therefore ſome Tables are to be made, by which we may know, when the commutation was to be made and into what Epacts.

4. Firſt therefore there was made a Table called *Tabula Epactarum Expanſa*, in this manner.

Firſt on the top were placed the 19 Golden Numbers in order, beginning with the Number 3, which in the old Calendar is placed againſt the Calends of *January*, and under every one of theſe Golden Numbers there are placed 30 Epacts all conſtituted from the loweſt number in the firſt rank in which the Epact is 1, and in that firſt rank the Golden Number is 3, the reſt from

thence

thence towards the right Hand are made by the constant addition of it, and the casting away of 30, as often as they shall exceed that number, only when you come to the 27, the Epact under the Golden Number 19, there must be added 12 instead of 11, that so the Epact following may be 9 not 8, for the Reasons already given in this Discourse concerning the Golden Number and Embolismical years. And this rank being thus made, the other Epacts are disposed in their natural order ascending upwards, and the number once again resumed after the Epact 30 or rather this Asterisk * set in the place thereof: only observe that under the Golden Number 12. 13. 14. 15. 16. 17. 18. 19. in the place of XX there is yet 25 in the common Character. And to the Epacts under the Golden Number 19, 12 must still be added to make that Epact under the Golden Number 1. As was said before concerning the lowest Rank.

5. And on the left hand of these Epacts before those under the Golden Number 3. are set 30 Letters of the Alphabet, 19 in a small Character, and 11 in a great, in which some are passed by, for no other reason save only this, that their similitude with some of the small Letters, should not occasion any mistake in their use, which shall be shewed in its place.

6. Besides this Table there was another Table made which is called *Tabula Æquationis Epactarum*, in which there is a *series* of years, in which the Moon, by reason of her mentioned anticipation, doth need Æquation, and in which the number of Epacts signed with the letters of the Alphabet, are to be changed; being otherwise Æ-

quated where it needeth, by the ſuppreſſion of the Biſſextile days.

7. But it ſuppoſeth, that it was convenient to ſuppreſs the Biſſextiles once only in 100 years; and the Moon to be æquated, or as far as concerns her ſelf, the rank of Epacts to be changed, once only in 300 years, and the 12 years and a half more, to be referred till after the years 2400, they do amount unto 100 years, and then an æquation to be made: but then it muſt be made by reaſon of the interpoſing this hundred not in the three hundredth but the hundredth year. Moreover this æquation is to be made as in referece to the Moon only, becauſe as the ſuppreſſion of the Biſſextiles intervene, the order of changing the ranks of Epacts is varied, as ſhall be ſhewed hereafter.

8. Again this Table ſuppoſeth, that ſeeing the New Moon at the time of the Nicene Council was upon the Calends of *January*, the golden Number 3 being there placed, that it would have been the ſame if the Epact * had been ſet to the ſame Calends, that is if the Epacts had been then in uſe. And therefore at that time the higheſt or laſt rank of Epacts was to be uſed, whoſe Index is *P*, and then after 300 years, the loweſt or firſt rank ſhould ſucceed, whoſe *Index* is *a*, (for the letters return in a Circle) and after 300 years more, the following rank whoſe *Index* is *b* and ſo forward; but that it is conceived, that the New Moon in the Calends of *January*, is more agreeable to the year of Chriſt 500, than the time of the Nicene Councel; and therefore as if the rank of Epacts under the letter *l* were ſutable to the year 500, it ſeemed good

good to make use of that rank under the letter *a* in the year of Christ 800, and those under the letter *b*, in the year 1100, and those under the letter *c* in the year 1400.

9. Which being granted, because in the year 1582, ten days were cut off from the Calendar, we must run backward, or in an inverted order count 10 *series*, designed, suppose, by the letters *b. a. P. N. M. H. G. F. E. D.* so that from the year 1582 the *series* of Epacts whose literal *Index* is *D*, is to be used, and this is that rank of Epacts which is now used in the Church of *Rome*.

10. And therefore as if this Table had its beginning from that year; the first number in the second column is 1582, and then in order under it. 1600. 1700. 1800. 1900. 2000. *&c.* And in the third Column every fourth hundred year is marked for a Bissextile, that is, 1600. 2400. 2800, *&c.* and in the fourth Column to every three hundreth Year is set this Character *C*, to shew in what year the Moon by her Anticipation of one day, doth need æquation; but in the year 1800 the double character is set *CC*, to signify that then another hundred years are gotten by the 12 years and a half reserved, besides and above the other 300 years; and this character is also set to the years 4300. 6800, and for the same reason.

But in the first Column, or on the left hand of these years are placed the Letters or *Indices* of those ranks of Epacts in the former Table, which are to be used in those years and when the Letters are charged. Thus against the year 1600 the Letter *D* is continued, to shew that from that

year, to the year 1700 the rank of Epacts is still to be used, which do belong to that Letter. And for as much as the Letter *C* is set to the year 1700, it sheweth that that rank of Epacts is then to be used, which do belong thereto, and so of the rest.

11. The reason why these Letters in the first Column are sometimes changed in 100 years, sometimes in 200, sometimes not in less then 300 Years, and that they are sometimes taken forward, sometimes backward, according to the order of the Alphabet, is because the suppression of the Bissextiles do intervene with the lunar æquation: for if the Bissextile were only to be suppressed, in these 300 or sometimes 400 years, in which the Moon needeth æquation, the rank of Epacts in that case would need no commutation, but would continue the same for ever; and the golden Number would have been sufficient, if the suppression of the Bissextile, and anticipation of the Moon, did by a perpetual compensation cause the new Moons still to return to the same days: but because the Bissextile is ofttimes suppressed, when the Moon hath no æquation, the Moon hath sometimes an æquation when the Bissextile is not suppressed, sometimes also both are to be done and sometimes neither; all which varieties may yet be reduced to these three Rules.

1. As often as the Bissextile is suppressed without any æquation of the Moon, then the letter which served to that time shall be changed to the next below it contrary to the order of the Alphabet. And the new Moons shall be removed one

one day towards the end of the Year.

2. As often as the Moon needeth æquation, without ſuppreſſion of the Biſſextile, then the Letter which was in uſe to that time ſhall be changed to the next above it according to the order of the Alphabet, that the New Moons may again return one day towards the beginning of the year.

3. As often as there is a Suppreſſion and an æquation both, or when there is neither, the Letter is not changed at all but that which ſerved for the former Centenary, ſhall alſo continue in the ſucceeding; becauſe the compenſation ſo made, the New Moons do neither go forward nor backward, but happen in the compaſs of the ſame days.

1. And this is enough to ſhew for what reaſon the letters are ſo placed in the Table, as there you ſee them: for in the year 1600 the Biſſextile being neither ſuppreſſed, nor the Moon æquated, the letter *D* uſed in the former Centenary or in the latter part thereof from the year 1582, is ſtill the ſame.

In the year 1700, becauſe there is a ſuppreſſion, but no æquation, the commutation is made to the Letter *C* deſcending.

In the Year 1800, becauſe there is both a ſuppreſſion and an æquation, the ſame letter *C* doth ſtill continue.

In the Year 2400, becauſe there is an æquation and no ſuppreſſion, there is an aſcenſion to the Letter *A*.

And thus you ſee not only the conſtruction of this Table, but how it may be continued to any other Year, as long as the World ſhall laſt.

12. And

12. And by these two Tables we may easily know which rank of the 30 Epacts doth belong to, or is proper for any particular age: for as in our age, that is, from the Year 1600 to the Year 1700 exclusively, that *series* is proper whose *Index* is *D*. Namely, 23, 4, 15, 26, *&c.* so in the two Ages following, that is, from the Year 1700 to the Year 1900 exclusively, that *series* is proper whose *Index* is *C*, namely these, 22, 3, 14, 25. and in the three ages following thence, that is from the Year 1900 to the Year 2100 exclusively, that *series* is proper whose *Index* is *B*, namely these, 21, 2, 13, 24, *&c.* And so for any other.

Hence also it may be known, which of the 19 doth belong to any particular Year, for which no more is necessary, than only to know the Golden Number for the year given, which being sought in the head of the Table, and the *Index* of that Age in the side, the common Angle, or meeting of these two, will shew you the Epact desired: As in the year 1674 the Golden Number is 3 and the *Index D*; therefore in the common Angle I find 23 for the Epact that year, and sheweth the New Moons in every Month thereof.

And here it will not be unseasonable to give the reason, for which the Epact 25 not XXV is written under the Golden Numbers 12, 13, 14, 15, 16, 17, 18, 19. namely, because the ranks of Epacts, which under these greater Numbers hath this Epact 25, hath also XXIV, it would follow that in these Ages in which any of these Ranks were in use, the New Moon in 19 years will happen twice upon the same days, in those six Months in which the Epacts XXV and XXIV are set to the same day: Whereas the New Moons do not hap-

pen

pen on the ſame day till 19 years be gone about. To avoid this inconvenience, the Epact 25 not XXV is ſet under theſe great numbers, and the Epact 25 is in the Calendar, in theſe Months ſet with the Epact XXVI, but in the other Months with the Epact XXV.

14. Hence it cometh to paſs, 1. That in theſe Years the Epacts 25 and XXIV do never meet on the ſame day. 2. That there is no danger that the Epacts 25 and XXVI ſhould in theſe 6 Months cauſe the ſame inconvenience, ſeeing that the Epacts 25 and XXVI are never both found in the ſame Rank. 3. That the Epact 25 may in other Months without inconvenience be ſet to the ſame day with the Epact XXVI, becauſe in theſe there is no danger of their meeting with the Epact XXIV on the ſame days. 4. That there is no fear that the Epacts XXV and XXIV being ſet on the ſame days, ſhould in future Ages cauſe the ſame inconvenience, becauſe the Epacts XXV and XXIV are not found together in any of the other Ranks. But that either one or both of them are wanting. Beſides, when one of theſe Epacts is in uſe, the other is not, and that only which is in uſe is proper to the day. As in this our Age until the Year 1700 the Epacts in uſe are thoſe in the rank whoſe *Index* is *D*. In which theſe two XXIV and XXV are not both found. And in the two following Ages, becauſe the rank of Epacts in uſe is that whoſe *Index* is *C*, in which there is the Epact XXV, not XXIV, the New Moons are ſhewed by the Epact XXV not by XXIV. But becauſe in three following Ages, the rank of Epacts in uſe is that whoſe *Index* is *B*, in which 25 and XXIV are both found, the New

Moons

Moons are ſhewed by the Epact XXIV when the golden Number is 6. And by the Epact 25 when the golden Number is 17, and not by the Epact XXV.

15. And if it be asked why the Epact 19 in the common Character is ſet with the Epact XX againſt the laſt day of *December*; know that for the reaſons before declared, the laſt Emboliſmical Month within the ſpace of 19 years, ought to be but 29 days and not 30, as the reſt are; and therefore when the Epact 19 doth concur with the golden Number 19, the laſt Month or laſt Lunation beginning the ſecond of *December*, ſhall end upon the 30 and not upon the 31 of that Month, and the New Moon ſhould be ſuppoſed to happen upon the 31 under the ſame Epact 19, that 12 being added to 19 and not 11, you may have one for the Epact of the year following, which may be found upon the 30 of *January*, as if the Lunation of 30 days had been accompliſhed the Day before.

CHAP. VI.

How to find the Dominical Letter and Feaſt of Eaſter according to the Gregorian account.

HAving ſhewed for what reaſon, and in what manner the Epacts are ſubſtituted in the place of the golden Number, and how the New Moons may be by them found in the Calendar for ever; I ſhall now ſhew you how to find the Feaſt of Eaſter and the other moveable Feaſts

Feasts according to the Gregorian or new account; and to this purpose I must first shew you how to find the Dominical Letter, for that the Cycle of 28 years will not serve the turn, because of the suppression of the Bissextile once in a hundred years, but doth require 7 Cycles of 28 years apeice. The first whereof begins with *C B*, and endeth in *D*. The second begins with *D C*, and endeth in *E*. The third begins with *E D*, and endeth in *F &c.* The first of these Cycles began to be in use 1582, in which year the dominical Letter according to the Julian account was *G*, but upon the fifteenth day of *October*, that Year was changed to *C*: for the fifth of *October* being Friday and then called the fifteenth, the Letter *A* became Friday, *B* Saturday, and *C* Sunday, the remaining part of the year, in which the Cycle of the Sun was 23, and the second after the Bissextile or leap Year, and so making *C*, which answereth to the fifteenth year of that Circle, to be 23, the Circle will end at *D*; and consequently *C B*, which in the old account doth belong to the 21 year of the Circle, hath ever since been called the first, and so shall continue until the year 1700, in which the Bissextile being suppressed, the next Cycle will begin with *D C* as hath been said already. Under the first rank or order of Dominical Letters are written the years 1582 and 1600, under the second 1700, under the third 1800, under the fourth 1900 and 2000, under the fifth 2100, under the sixth 2200 and under the seventh 2300 and 2400. And again under the first Order, 2500, under the second 2600, under the third 2700 and 2800, and so forward as far as you

please,

please, always observing the same order, that the 100 Bissextile years may still be joyned with the not Bissextile immediately preceding.

1. And hence it appears, that the seven orders of Dominical Letters, are so many Tables, successively serving all future Generations. For as the first Order serveth from the year 1582 and 1600 to the year 1700 exclusively, and the second Order from thence to the year 1800 exclusively, so shall all the rest in like manner which here are set down, and to be set down at pleasure. And hence the Dominical Letter or Letters may be found for any year propounded, as if it were required to find the dominical Letter for the year 1674, because the year given is contained in the centenary 1600. I find the Cycle of the Sun by the Rule already given to be 3. In the first order against the number 3, I find *G* for the Sunday Letter of that year, in like manner because the year 1750 is contained under the Centenary 1700, the Cycle of the Sun being 27, I find in the second rank the Letter *D* answering to that Number, and that is the Dominical Letter for that year, and so of the rest.

3. Again for as much as the fifth Order is the same with that Table, which serves for the old account, therefore that order will serve the turn for ever where that Calendar is in use, and so this last will be of perpetual use to both the Calendars.

4. Now then to find the time in which the Feast of *Easter* is to be observed, there is but little to be added to that which hath been already said concerning the Julian Calendar. For the Paschal

chal Limits are the same in both, the difference is only in the Epacts, which here are used instead of the golden Number.

5. For the terms of the Paschal New Moons are always the eighth of *March* and the fifth of *April*: but whereas there are 11 days within these Limits to which no golden Number is affixed, there is now one day to which an Epact is not appointed, because there is no day within those Limits, on which in process of time a New Moon may not happen. And the reason for which the two Epacts XXV and XXIV are both set to the fifth of *April*, is first general, which was shewed before, namly that by doing the same in 5 other Months, the 12 time 30 Epacts might be contracted to the Limits of the lunar Year which consists of 354 days: but there is a particular reason also for it, that the Antients having appointed that all the Paschal lunations should consist of 29 days, it was necessary that some two of the Epacts should be set to one of these days in which the Paschal lunation might happen, the Epacts being 30 in number. And it was thought convenient to choose the last day, to which the Epact XXV belonging, the Epact XXIV should also be set; and hence by imitation it comes to pass, that these and not other Epacts are set to that day in other Months, in which two Epacts are to be set to the same days.

6. The use of these Epacts in finding the Feast of *Easter*, is the same with that which hath been shewed concerning the golden Numbers. For the Epact and the Sunday Letter for that year propounded being given, the Feast of *Easter* may be found in the Calendar after the same manner.

manner: Thus in the year 1674, the Epact is 23 and the Sunday Letter *G*, and therefore reckoning fourteen days from the eighth of *March* to which the Epact is ſet, the Sunday following is *March* 25, which is the day on which the Feaſt of *Eaſter* is obſerved.

7. And hence as hath been ſhewed in the third Chapter concerning the Julian Calendar, a brief table may be made to ſhew the feaſt of *Eaſter* and the other moveable Feaſts for ever, in which there is no other difference, ſave only that the Epacts as they are in this new Calendar, are to be uſed as the golden Numbers are, which ſtand in the old Calendar. And a Table having the golden Numbers of the old Calendar ſet in one Column, and the Epacts as they are in the new Calendar ſet in another, will indifferently ſhew the movable Feaſts in both accounts, as in the Year 1674, the golden Number is 3 and the Sunday Letter according to the Julian account is *D*, according to the Gregorian *G*, and the Epact 23, and therefore according to this Table our *Eaſter* is *April* 19, and the other, to wit, the Gregorian, is *March* 25. The like may be done for any other year paſt or to come.

CHAP. VII.

CHAP. VII.

How to reduce Sexagenary numbers into Decimal, and the Contrary.

EVery Circle hath antiently, and is yet generally supposed to be divided into 360 degrees, each degree into 60 Minutes, each Minute into 60 Seconds, and so forward as far as need shall require. But this partition is somewhat troublesom in Addition and Subtraction, much more in Multiplication and Division; and the Tables hitherto contrived to ease that manner of computation, do scarce sufficiently perform the work, for which they are intended. And although the Canon published by the learned *H. Gellibrand*, in which the Division of the Circle into 360 degrees is retained, but every degree is divided into 100 parts, is much better than the old Sexagenary Canon, yet some are of opinion, that if the Antients had divided the whole circle into 100 or 1000 parts, it would have proved much better then either; only they think Custome such a Tyrant, that the alteration of it now will not be perhaps so advantagious; leaving them therefore to injoy their own opinions, they will not I hope be offended if others be of another mind: for their sakes therefore, that do rather like the Decimal way of calculation, Having made a Canon of artificial Signs and Tangents for the degrees and parts of a Circle divided into 100 parts, I shall here also shew you, how to reduce sexagenary Numbers into Decimal, and the contrary,

ry, as well in time as motion.

2. The parts of a Circle consisting of 360 degrees, may be reduced into the parts of a circle divided into 100 degrees or parts, by the rule of Three in this manner.

As 360 is to 100, so is any other Number of degrees, in the one, to the correspondent degrees and parts in the other.

But if the sexagenary degrees have Minutes and Seconds joyned with them, you must reduce the whole Circle as well as the parts propounded into the least Denomination, and so proceed according to the rule given.

Example. Let it be required to convert 125 degrees of the Sexagenary Circle, into their correspondent parts in the Decimal. I say, as 360 is to 100, so is 125 to 34, 722222, *&c.* that is, 34 degrees and 722222 Parts.

2. Example. Let the Decimal of 238 degrees 47 Minutes be required. In a whole Circle there are 21600 Minutes, and in 238 degrees, there are 14280 Minutes, to which 47 being added the sum is 14327. Now then I say if 21600 give 100, what shall 14327. The Answ. is 66,3287 *&c.* In like manner if it were required to convert the Hours and Minutes of a Day into decimal Parts, say thus, if 24 Hours give 100, what shall any other number of Hours give. Thus if the Decimal of 18 hours were required, the answer would be 75, and the Decimal answering to 16 Hours 30 Minutes is 68, 75.

But if it be required to convert the Decimal Parts of a Circle into its correspondent Parts in Sexagenary. The proportion is; as 100 is

to

to the Decimal given, so is 360 to the Sexagenary degrees and parts required.

Example. Let the Decimal given be 34, 722222, if you multiply this Number given by 360, the Product will be 124999992, that is cutting off 7 Figures, 124 degrees and 9999992 parts of a degree. If Minutes be required, multiply the Decimal parts by 60, and from the product cut off as many Figures, as were in the Decimal parts given, the rest shall be the Minutes desired.

But to avoid this trouble, I have here exhibited two Tables, the one for converting sexagenary degrees and Minutes into Decimals, and the contrary. The other for converting Hours and Minutes into Decimals, and the contrary. The use of which Tables I will explain by example.

Let it be required to convert 258 degrees 34′. 47″, into the parts of a Circle decimally divided.

The Table for this purpose doth consist of two Leaves, the first Leaf is divided into 21 Columns, of which the 1. 3. 5. 7. 9. 11. 13. 15. 17. 19 doth contain the degrees in a sexagenary Circle, the 2. 4. 6. 8. 10. 12. 14. 16. 18 and 20 doth contain the degrees of a Circle Decimally divided, answering to the former, and the last Column doth contain the Decimal parts, to be annexed to the Decimal degrees. Thus the Decimal degrees answering to 26 Sexagenary are 7, and the parts in the last Column are 22222222 and therefore the degrees and parts answering to 26 Sexagenary degrees are 7. 22222222.

In like manner the Decimal of 62 degrees, 17. 22222222. And the Decimal of 258 degrees, 34′. 47″, is thus found.

The Decimal of 258 degrees is	71.66666666
The Decimal of 34 Minutes is	.15747040
The Decimal of 47 seconds is	.00362652
Their Sum	71.82776358

is the Decimal of 258 degrees, 34′. 47″ as was required.

In like manner the Decimal of any Hours and Minutes may be found by the Table for that purpose.

Example. Let the Decimal of 7 Hours 28′ be required.

The Decimal answering to 7 h. is	29.16666667
The Decimal of 28 Minutes is	1.94444444
The Sum	31.11111111

is the Decimal Sought.

To find the degrees and Minutes in a sexagenary Circle, answering to the degrees and parts of a Circle Decimally divided, is but the contrary work.

As if it were required to find the Degrees and minutes answering to this decimal 71.02776359, the Degrees or Integers being sought in the 2. 4. 6 or 8 Columns &c. of the first Leaf of that Table, right against 71. I find 256 and in the last Column these parts 1111111, which being less than the Decimal given, I proceed till

till I come to 6666667, which being the nearest to my number given, I find against these parts under 71. Degrees 258, so then 258 are the degrees answering to the Decimal given and,

To find the Minutes and Seconds from	71.82776359
I Substract the number in the Table	71.66666667
The remainer is	16109692
which being Sought in the next Leaf under the title Minutes, the next leaf is	11747640
And the Minutes 34, and this number being Subtracted the remainer is	00362652

Which is the Decimal of 47 seconds, and so the degrees and Minutes answering to the Decimal given are 258 degrees 34′ and 47″, the like may be done for any other.

CHAP. VIII.

Of the difference of Meridians.

HAving in the first part shewed how the places of the Planets in the Zodiack may be found by observation, and how to reduce the time of an observation made in one Country, to the correspondent time in another, as to the day of the Month, by considering the several

measures of the year in several Nations, there is yet one thing wanting, which is, by an observation made of a Planets place in one Country to find when the Planet is in that place in reference to another; as suppose the ☉ by observation was found at *Uraniburg* to be in ♈. 3^{d}. 13′. 14″. *March* the fourteenth 1583 at what time was the Sun in the same place at *London*? To resolve this and the like questions, the Longitude of places from some certain Meridian must be known; to which purpose I have here exhibited a Table shewing the difference of Meridians in Hours and Minutes, of most of the eminent places in *England*, from the City of *London*, and of some places beyond the Seas also. The use whereof is either to reduce the time given under the Meridian of *London* to some other Meridian, or the time given in some other Meridian to the Meridian of *London*.

1. If it be required to reduce the time given under the Meridian of *London* to some other Meridian, I seek the place desired in the Catalogue, and the difference of time there found, either add to or subtract from the times given at *London*, according as the Titles of Addition or Subtraction shew, so will the time be reduced to the Meridian of the other place as was required. Example. The same place at *London* was in the first Point of ♉, 6 Hours *P.M.* and it is required to reduce the same to the Meridian of *Uraniburg* I therefore seek in *Uraniburg* in the Catalogue of places, against which I find 50′ with the Letter *A* annexed, therefore I conclude, that the Sun was that day at *Uraniburg* in the first point of ♉, 6 Hours 50′. *P. M.*

2. If

2. If the time given be under some other Meridian, and it be required to reduce the same to the Meridian of *London*, you must seek the place given in the Catalogue, and the difference of time there found, contrary to the Title is to be added or subtracted from the time there given.

Example. Suppose the place of the Sun had been at *Uraniburg*, at 6 Hours 50′. *P. M.* and I would reduce the same to the Meridian of *London*; against *Uraniburg* as before I find 50′ *A*, therefore contrary to the Title I Subtract 50′ and the remainder 6 Hours is the time of the Suns place in the Meridian of *London*.

CHAP. IX.

Of the Theory of the Sun's or Earth's Motion.

IN the first part of this Treatise we have spoken of the primary Motion of the Planets and Stars, as they are wheeled about in their diurnal motion from East to West, but here we are to shew their own proper motions in their several Orbs from West to East, which we call their second motions.

1. And these Orbs are supposed to be Elliptical, as the ingenious *Kepler*, by the help of *Tycho's* accurate observations, hath demonstrated in the Motions of *Mars* and *Mercury*, and may therefore be conceived to be the Figure in which the rest do move.

2. Here then we are to consider what an *Ellipsis* is, how it may be drawn, and by what Method

thod the motions of the Planets according to that Figure may be computed.

3. What an *Ellipsis* is *Apollonius Pergæus in Conicis*, *Claudius Mydorgius* and others have well defined and explained, but here I think it ſufficient to tell the Reader, that it is a long Circle, or a circular Line drawn within or without a long Square; or a circular Line drawn between two Circles of different Diameters.

4. The uſual and Mechanical way of drawing this *Ellipſis* is thus; firſt draw a line to that length which you would have the greateſt Diameter to be, as the Line *AP* in Figure 8, and from the middle of this Line at *X*, ſet off with your compaſſes the Equal diſtance *XM* and *XH*.

5. Then take a piece of thred of the ſame length with the Diameter *AP* and faſten one end thereof in the point *M* and the other in the point *H*, and with your Pen extend the thred thus faſtened to the point *A*, and from thence towards *P* keeping the thread ſtiff upon your Pen, draw a line from *A* by *B* to *P*, the line ſo drawn ſhall be half an *Ellipſis*, and in like manner you may draw the other half from *P* by *D* to *A*. In which becauſe the whole thred is equal to the Diameter *AP*. therefore the two Lines made by thred in drawing of the *Ellipſis*, muſt in every point of the ſaid *Ellipſis* be alſo equal to the ſame Diameter *AP*. They that deſire a demonſtration thereof geometrically, may conſult *Apollonius Pergæus*, *Claudius Mydorgius* or others, in their treatiſes of Conical Sections, this is ſufficient for our preſent purpoſe, and from the equality of theſe two Lines with the Diameter, a brief Method of calculation of the

Planets

Planets place in an *Ellipsis*, is thus Demonstrated by Dr. *Ward* now Bishop of *Salisbury*.

6. In this *Ellipsis H* denotes the place of the Suns Center, to which the true motion of the Planet is referred, *M* the other *Focus* whereunto the equal or middle motion is numbred, *A* the *Aphelion* where the Planet is farthest distant from the Sun and slowest in motion, *P* the *Perihelion* where the Planet is nearest the Sun and swiftest in motion. In the points *A* and *P* the Line of the mean and true motion do convene, and therefore in either of these places the Planet is from *P* in æquality, but in all other points the mean and true motion differ, and in *D* and *C* is the greatest elliptick Æquation.

8. Now suppose the Planet in *B*, the line of the middle motion according to this Figure is *MB*, the line of the true motion *HB*. The mean Anomaly *AMB*. The Eliptick æquation or *Prosthaphæresis MBH*, which in this Example subtracted from *AMB*, the remainer *AHB* is the true Anomaly. And here note that in the right lined Triangle *MBH*, the side *MH* is always the same, being the distance of the *Foci*, the other two sides *MB* and *HB* are together equal to *AP*. Now then if you continue the side *MB* till *BE* be equal to *BH* and draw the line *HE*, in the right lined Triangle *MEH*, we have given $ME = AD$ and *MH* with the Angle *EMH*, to find the Angles *MEH* and *MHE* which in this case are equal, because $EB = BH$ by Contraction, and therefore the double of *BEH* or $BHE = MBH$, which is the Angle required.

And that which yet remaineth to be done, is the

the finding the place of the *Aphelion*, the true Excentricity or distance of the umbilique points, and the stating of the Planets middle motion.

CHAP. X.

Of the finding of the Suns Apogeon, *quantity of Excentricity and middle motion.*

THe place of the Suns *Apogæon* and quantity of Excentricity may from the observations of our countrey man Mr. *Edward Wright* be obtained in this manner, in the years 1596, and 1497, the Suns entrance into ♈ and ♎ and into the midst of ♉. ♌. ♍ and ♒ were as in the Table following expressed.

	1596 D. H. M.	1597 D. H. M.		
January.	25.00.07	24.05.54	♒	15
March.	9.18.43	10.00.37	♈.	0
April.	24.21.47	25.03.54	♉.	15
July.	28.01.43	28.09.56	♌.	15
September.	12.13.48	12.19.15	♎.	0
October.	27.15.23	27.21.50	♍.	15

And hence the Suns continuance in the Northern Semicircle from ♈ to ♎ in the year 1596 being Leap-year, was thus found.

From

	d. h. '
From the 1. of *January* to ☉ Entrance ♎.	256.13.48.
From the 1. of *Jun* to ☉ Entrance ♈	69.18.43
Their difference.	186.19.05

In the year 1597 from the 1 of *January* to the time of the ☉ Entrance into ♎. 255.19.15
To the ☉ entrance into ♈. 69.09.37
Their difference is 186.18.38

And the difference of the Suns continuance in these Arks in the year 1596 and 1597 is 27'. and therefore the mean time of his continuance in those Arks is days 186. hours 18. minutes 51. seconds 30. And by consequence his continuance in the Southern Semicircle that is from ♎ to ♈ is 178 days. 11 hours, 8 minutes and 30 seconds.

In like manner in the year 1596 between his entrance into ♉ 15. and ♏ 15, there are days 185.17.36
And in the year 1597 there are days 185.17.56

And to find the middle motion answering to days 186. hours 18. Minutes 51. seconds 30 I say.

As 365 days, 6 hours, the length of the Julian, year is to 360, the degrees in a Circle.

So is 186 days, 18 hours, 51'. 30" to 184 degrees. 03'. 56".

In like manner the mean motion answering to

to 185 days, $17^{h.}$ 46′ is 183 degrees, 02′.09,′

Apparent motion from ♈ to ♎	180. 00. 00
Middle motion	184. 03. 56
Their Sum	364. 03. 56
Half Sum is the Arch. *SME*	182. 01. 58

In 1596 from 15 ♒ to 15 ♌ there are days 185, hours 01, minutes 36. In 1597. days 135. hours 4. 02′.

And the mean motion anſwering thereunto is. $182^{d.}$ 30′. 36″.

Apparent motion from 15 ♉ to 15 ♍.		180.
Middle motion	185. 17. 56.	181.04.53
Half Sum is		183.32.26

From 15 ♒ to 15 ♌. Days. 185. $04^{h.}$ 02′

Apparent motion	180.
Middle motion	182. 30. 36
Half Sum	181. 15. 18

Now then in *Fig.* from *PGC*. 181.32.26 deduct *NKD* 180, the Remainer is *DC*-|-*NP*. 1. 32. 26. Therefore *DC* or *NP*. 46. 13, whoſe Sine is *HA*.

And from *XPG*. 181. 15. 18 deduct *TNK* 180, the Remainer is *KG* -|- *TX* 1. 15. 18. Therefore *KG* or *TX* 37. 39, whoſe Sine is *HR*.

Now

Now then to find the Apogæon.

As *HA* 46′. 13″		5.12851105
To *Rad.* So *HR*	37′. 39″	15.03948202
To *Tang. HAR.*	39^d. 10′. 04″	9.91097097
GAM.	45	
Apogæon	95. 49. 56.	

Hence to find the excentricity AR.

As the Sine *HAR.*	39. 10. 04	9.80043756
To *Rad.* So *HR.*	37. 39	15.03948202
To *RA.*	1733.99	5.23904446

1848
♒ 29.16
♓ 29.23
♈ 30.11
♉ 31.0
♊ 31.8
♋ 31.10
♌ 31.6.3
♍ 30.20
♎ 30.7
♏ 29.20
♐ 29.12
♑ 29.10
N. 186.16.5
S. 178.14
Aphelion
July 9^h.16

Or thus,

In the Triangle *AR*♈ we have given *A*♈. and *R*♈.

As *A*♈.	37. 39	5.03948202
To *Rad.* So *R*♈.	46. 13	15.12851105
To *Tang. RA*♈.	50. 49. 56	10.08902903
PAS.	45.	

Apogæon 95 *deg.* 49′. 56″. as before.

Then for the Excentricity RA.

As the Sine of *RA*♈.	50. 49. 56	9.88945938
Is to *R*♈. 46′. 13″		5.12851105
So is *Radius.* To *RA.*	1734. 01	5.23905167

And this agreeth with the excentricity, used by

by Mr. *Street* in his *Aſtron. Carolina*, Pag. 23. But Mr. *Wing* as well by obſervation in former ages, as our own, in his *Aſtron. Inſtaur.* Pag. 39. doth find it to be 1788 or 1791. The work by both obſervations as followeth.

2. And firſt in the time of *Ptolemy*, *Anno Chriſti* 139 by comparing many obſervations together, he ſets down for the meaſure neareſt truth, the interval between the vernal Equinox and the Tropick of Cancer to be days 93. hours 23. and minutes 03. And from the Vernal to the Autumnal Equinox, days 186. hours 13. and minutes 5.

	D.
The apparent motion from ♈ to ♋	90.36.00
Middle motion for $93^{d.}$ $23^{h.}$ $3'$. is	92.36-42
The half Sum is *G P*	91.18.21
Apparent motion from ♈ to ♎	180.00.00
Middle motion for $186^{d.}$ $13^{h.}$ $5'$. is	183.52.03
The half Sum is *G E K*	181.56.02
The half of *GEK* is *GE.*	90.58.01
And *GP* leſs *GE* is	00.20.20
Whoſe Sum is *AC* 59146.	

Again from *GEK* 181. 56. 02. deduct the Semicircle *FED* 180. the remainer is the ſumm *DK* and *FG.* 1. 56. 2. and therefore *DK*=*FG.* 58′. 01″. whoſe ſign is *BC.* 168755. *L* is the place of the *Aphelion*, and *AB* the Excentricity.

Now then in the Triangle *ABC.* in the Fig. 6 we have given the two ſides *AC* and *BC.* To find the Angle *BAC* and the Hypotenuſe *AB.*

For

For which the proportions are.

As the side *AC*. 59146	4.77192538
Is to the Radius.	10.00000000
So is the side *BC* 168755	5.22725665
To Tang. *BAC*. 70. 41. 10.	10.45533127

Secondly for AB.

As the Sine of *BAC*. 70. 41. 10.	9.97484352
Is to the side *AB*. 168755.	5.22725665
So is the Radius.	10.00000000
To the Hypot. *AB*. 1788. 10.	5.25241313

Therefore the *Aphelion* at that time was in ♊ 10. 41. 10. And the excentricity. 1788.

3. Again *Anno Christi* 1652 the Suns place by observation was found to be as followeth.

April.	24.	hours.	10.	♉.	15
October.	27.	hours.	7. 10′	♍.	15
January.	24.	hours.	11. 20′	♒.	15
July.	27.	hours.	16. 30,	♌.	15

Hence it appeareth that the Sun is running through one Semicircle of the Ecliptick, that is from ♉ 15 to ♍ 15. 185 days 21 hours and 10′. And through the other Semicircle from ♒ 15 to ♌ 15, days 184. hours 5. therefore the Suns mean motion, according to the practice in the last example, from ♉ 15 to ♍ 15 is 181. 30. 26. and from ♒ 15 to ♌ 15. 181. 16. 30.

Now then in Fig. 7. if we subtract the semicircle of the Orb *KMH*. 180. from *WPV* 181. 36. 26. the remainder is the sum of *KW* and *HV*

1. 36. 26. the Sine of half thereof 48′. 13″ is equal to *AC*. 140252.

Again the mean motion of the Sun in his Orb from ♒ 15 to ♉ 15 is the Arch *SKP*. 181. 16. 30. whose excess above the Semicircle being bisected is 38. 15. whose Sine *CB*. 111345. now then in the Triangle *ABC* to find the Angle *BAC*, the proportion is.

As the side *AC*. 140252	5.14690906
Is to the *Radius*.	10.00000000
So is the Side *CB* 111345	5.04667072
To Tang. *BAC*. 38. 36. 21,	9.89966166

Which being deducted out of the Angle. 69. *A* ♌. 45 it leaveth the Angle 69 *AL* 6. 33. 39. the place of the ☉ *Aphelion* sought, and this is the quantity which we retain.

And for the excentricity BC.

As the Sum of *BAC*. 38.26.21	9.79356702
Is to the *Radius*.	10.00000000
So is the side *BC* 111345	5.04667072
To the Hypot. *AB*. 179103	5.25310370

So then *Anno Christi*. 1652. *Aphel.*	96.33.39
Anno Christi. 139. the *Aphelion*	70.41.10
Their difference is	25.52.29

And the difference of time is 1513 Julian years.

Hence to find the motion of the *Aphelion* for 2. years, say I, if 1513 years give 25.52.29, what shall one year give, and the answer is 00$^{d.}$ 01′ 01″,

$01''. 33'''. 56^{iv}. 44^{v}$: that is in Decimal numbers. 0.00475. 04447. 0555.

And the motion for. 1651 years. 7. 84298. 4208862, which being deducted from the place of the *Aphelion Anno Christi*. 1652——26.82245. 3703703. The remainer, *viz.* 18. 97946. 9494841 is the place thereof in the beginning of the Christian *Æra*, which being reduced is, 68 deg. 19. min. 33. sec. 56. thirds.

4. The Earths middle motion, *Aphelion* and Excentricity being thus found, we will now shew how the same may be stated to any particular time desired, and this must be done by help of the Sun or Earths place taken by observation. In the 178 year then from the death of *Alexander*, *Mechir* the 27 at 11 hours *P. M. Hipparcus* found in the Meridian of *Alexand.* that the Sun entered ♈ 0. the which Vernal Equinox happened in the Meridian of London according to Mr. *Wings* computation at 9 hours 14′, and the Suns *Aphelion* then may thus be found.

The motion of the *Aphelion* for one year, was before found to be. 0.00475.04447.0555. therefore the motion thereof for one day is 0.00001. 501491722. The Christian *Æra* began in the 4713 year compleat of the Julian Period, in which there are days 1721423. The *Æra Alexandri* began *November* the twelfth, in the year 4390 of the Julian Period, in which there are 1603397 days. And from the death of *Alexander* to the 27 of *Mechir* 178, there are days 64781, therefore from the beginning of the Julian Period, to the 178 year of the *Æra Alexandri*, there are days 1668178 which being deducted from the days in the Christian *Æra*.

1721423, the remainer is 53245, the number of days between the 178 year after the death of *Alexander, Mechir* 27, and the beginning of the Christian *Æra*.

Or thus. From the *Æra Alexandri* to the *Æra Christi* there are 323 Julian years, and 51 days, that is 118026 days. And from the *Æra Alexandri* to the time of the observation, there are 64781 days, which being deducted from the former, the remainer is 53245 as before. Now then if you multiply the motion of the *Aphelion* for one day, *viz.* 0.00001. 3014917 by 53245, the product is 0.69297.9255665, which being deducted from the place of the *Aphelion* in the beginning of the Christian *Æra*, before found. 18.97946. 9494841. the remainer 18. 28649. 0239176 is the place of the *Aphelion* at the time of the observation, that is in Sexagenary numbers. deg. 65. 49′. 53″.

5. The place of the *Aphelion* at the time of the observation being thus found to be deg. 65. 49′. 53″. The Suns mean Longitude at that time, may be thus computed.

In Fig. 8. In the Triangle *EMH* we have given the side *ME* 200000, the side *MH* 3576, the double excentricity before found, and the Angle *EMH* 114. 10′. 07″. the complement of the *Aphelion* to a Semicircle, to find the Angle *MEH*, for which the proportion is,

As the Summ of the sides, is to the difference of the sides, so is the Tangent of the half Summ of the opposite Angles, to the Tangent of half their difference.

The side *ME*. 200000.
The side *MH* 3576.

Z. Of the sides. 203576. *Co. ar.*		4.69127343
X. Of the sides. 196424.		5.29321855
Tang. ½ *Z* Angles. 32′.54′.56.		9.91111512
Tang. ½ *X* Angles. 31.59.21.		
Angle *MEH*. 0.55.35.		9.79560710

The double whereof is the Angle *MBH* 1.51.10. which being Subtracted from 360 the remainer 358. 08. 50. is the estimate middle motion of the Sun, from which subtracting the *Aphelion* before found, 65. 49. 53. the remainer 292. 18. 57. is the mean Anomaly by which the absolute Æquation may be found according to the former operation.

Z.ME+MH. 203576. *Co. ar.*		4.69127343
X.ME—MH. 196424		5.29321855
Tang. ½ Anom. 56. 09. 28.		10.17359517
Tang. ½ *X*. 55. 12. 18.		10.15808715
Differ. 00. 57. 10.		

Doubled 1. 54. 20, which added to the middle motion before found gives the ☉ true place ♈. 00. 3′. 10″, which exceeds the observation 3′. 10″. therefore I deduct the same from the middle motion before found, and the remainer 358. 05. 50. is the middle motion at the time of the observation of *Hipparchus*, to which if you add the middle motion of the Sun for 53245 days, or for 323 Ægyptian years 131 days, 280. 46. 08′ the Summ, rejecting the whole Circles, is 278. 51. 48 the Suns mean Longitude in the beginning of the Christian *Æra*.

6. But one observation is not sufficient, where-

 by

by to state the middle motion for any desired *Epocha*, we will therefore examine the same by another observation made by *Albategnius* at *Aracta* in the year of Christ 882, *March*: 15. hours 22. 21. but in the Meridian of *London* at 18 hours. 58′.

The motion of the *Aphelion* for 881 years, 74 days is 3. 80606865373, which being added to the place thereof in the beginning of the Christian *Æra*, the place at the time of the observation will be found to be 22.78553814857 8, that is reduced, Deg. 82. 01′. 40″. And hence the Æquation according to the former operations is Deg. 2. 01′. 16″ which being deducted from a whole Circle, the remainer 357^d. 58′. 44″ is the estimate middle motion at that time, from which deducting the *Aphelion* deg. 82. 01. 40. the remainer 275. 57. 04 is the mean anomaly, and the Æquation answering thereto is deg. 2. 02′. 18″ which being added to the middle motion before found, gives the ☉ place ♈. 00. 01′. 02″ which exceeds the observation 01′. 02″. therefore deduct the same from the middle motion before found, the remainer 357. 57′. 22″ is the middle motion of the ☉ at the time of the observation, from which deducting the middle motion for 881 years, 74 days, 18 hours, 58 minutes, *viz*. 80^d. 06′. 10″. the remainer 277 deg. 51′. 12″. is the ☉ mean Longitude in the beginning of the Christian *Æra*.

By the first observation it is deg.	278.51′. 48″
By the second	277.51.12
Their difference is	1.00.36

He

He that desires the same to this or any other *Epocha*, to more exactness, must take the pains to compare the Collection thereof from sundry Observations, with one another, this is sufficient to shew how it is to be found. Here therefore I will only add the measures set down by some of our own Nation, and leave it to the Readers choice to make use of that which pleaseth him best.

The ☉ mean Longitude in the beginning of the Christian Æra *according to.*

Vincent Wing is	9.	8d.	00′.	31″
Tho. Street is	9.	7.	55.	56
John Flamsted is	9.	7.	54.	39
By our first Computation	9.	8.	51.	48
By our second	9.	7.	51.	12

In the Ensuing Tables of the ☉ mean Longitude, we have made use of that measure given by Mr. *Flamsted*, a little pains will fit the Tables to any other measure.

CHAP. XI.

Of the quantity of the Tropical and Sydereal Year.

THe year Natural or Tropical (so called from the Greek word Τρέπω, (which signifies to turn) because the year doth still turn or return into it self) is that part of time in which the ☉ doth finish his course in the Zodiack

by coming to the ſame point from whence it began.

2. That we may determine the true quantity thereof, we muſt firſt find the time of the ☉ Ingreſs into the Æquinoctial Points, about which there is no ſmall difference amongſt Aſtronomers, and therefore an abſolute exactneſs is not to be expected, it is well that we are arrived ſo near the Truth as we are. Leaving it therefore to the ſcrutiny of after Ages, to make and compare ſundry Obſervations of the ☉ entrance into the Æquinoctial Points, it ſhall ſuffice to ſhew here how the quantity of the Tropical year may be determined, from theſe following obſervations.

3. *Albategnius*, *Anno Chriſti* 882 obſerved the ☉ entrance into the Autumnal Æquinox at *Aracta* in *Syria* to be *Sept.* 19. 1 hour 15′ in the Morning. But according to Mr. *Wings* correction in his *Aſtron. Inſtaur.* Page 44, it was at 1 hour 43′ in the Morning, and therefore according to the ☉ middle motion, the mean time of this Autumnal Æquinox was *Sept.* 16. $12^{h.}$ 14′. 25″. that is at *London* at $8^{h.}$ 54′. 25″.

4. Again by ſundry obſervations made in the year 1650. the ſecond from Biſſextile as that of *Albategnius* was, the true time of the ☉ ingreſs into ♎ was found to be *Sept.* 12. $14^{h.}$ 40′. and therefore his ingreſs according to his middle motion was *Sept.* 10. $13^{h.}$ 02.

5. Now the interval of theſe two obſervations is the time of 768 years, in which ſpace by ſubtracting the leſſer from the greater, I find an anticipation of 5 days, 9 hours, 52′. 25″. which divided by 768 giveth in the quotient

10′.

$10'. 55''. 39'''$ which being subtracted for 365 days, 6 hours, the quantity of the Julian year, the true quantity of the Tropical year will be 365 days, 5 hours, $49'. 04''. 21'''$. Others from other observations have found it somewhat less, our worthy countryman Mr. *Edward Wright* takes it to be $365^{d.}$ 5 hours. $48'$. 48″

Mr. *John Flamsted*, $5^{h.}$ $29'$. Mr. *Tho. Street* $5^{h.}$ $49'. 01''$. taking therefore the Tropical year to consist of 365 days, 5 hours, 49 Minutes, the Suns mean motion for one day is 0 deg. $59'. 8''. 19'''. 43^{iv.}\ 47^{v.}\ 21^{vi.}\ 29^{vii.}\ 23^{viii.}$ or in decimal Numbers, the whole Circle being divided into 100 degrees, the ☉ daily motion is 0. 27379. 08048. 11873.

6. The Sydereal or Starry year is found from the Solar by adding the Annual Motion of the eighth Orb or præcession of the Æquinoctial Points thereunto, that præcession being first converted into time.

7. Now the motion of the fixed Stars is found to be about $50''\frac{1}{2}$ in a years time, as Mr. *Wing* hath collected from the several observations of *Timocharis*, *Hipparchus*, *Tycho* and others; and to shew the manner of this Collection, I will mention onely two, one in the time of *Timocharis*, and another in the time of *Tycho*.

8. *Timocharis* then as *Ptolemy* hath it in his *Almagist*, sets down the Virgins Spike more northwardly than the Æquinoctial, 1 deg. $24'$. the time of this observation is supposed to be about 291 years before Christ, the Latitude 1 deg. $59'$ South, and therefore the place of the Star was in ♍. $21^{d.}$ $59'$. And by the observation of *Tycho* 1601 current, it was in ♎

18. 16′. and therefore the motion in one year 50″, which being divided by 365 days, 6 hours, the quotient is the motion thereof in a days time. 00′. 8‴. $12^{iv.}$ $48^{v.}$ $47^{vi.}$ $18^{vii.}$ $30^{viii.}$ $13^{ix.}$ and in decimal Numbers, the motion for a year is 00385. 80246. 91358. The motion for a day. 00001. 05626. 95938.

9. Now the time in which the Sun moveth 50″, is 20′. 17″. 28‴, therefore the length of the ſydereal year is 365 days, 6 hours, 9′. 17″. 28‴. And the Suns mean motion for a day 59′. 8‴. 19‴. $43^{iv.}$ $47^{v.}$ $21^{vi.}$ $29^{vii.}$ $23^{viii.}$ converted into time is 00. 03′. 56″. 33‴. $18^{iv.}$ $55^{v.}$ $9^{vi.}$ $23^{vii.}$ $57^{viii.}$ which being added to the Æquinoctial day, 24 hours, giveth the mean ſolar day, 24 hours. 3.′ 56″. 33‴. $18^{v.}$ 55. 9. 23. 57.

10. And the daily motion of the fixed Stars, being converted into time is $32^{iv.}$ $51^{v.}$ $15^{vi.}$ $9^{vii.}$ $14^{viii.}$ $24^{ix.}$ and therefore the Æquinoctial day being 24 hours, the ſydereal day is 24 hours, 00′. 00″. 00‴. $32^{iv.}$ 51. 15. 9. 14 24.

11. Hence to find the præceſſion of the Æquinoctial Points, or Longitude of any fixed Star, you muſt add or ſubtract the motion thereof, from the time of the obſervation, to the time given, to or from the place given by obſervation, and you have your deſire.

Example. The place of the firſt Star in Aries found by *Tycho* in the year 1601 current, was in ♈. $27^{d.}$ 37′. 00. and I would know the place thereof in the beginning of the Chriſtian *Æra*.

The

The motion of the fixed Stars for 1600 years,	22$^{d.}$ 13$'$.20$''$
Which being deducted from the place found by observ.	27. 37. 00
The remainer.	5.23.40

is the place thereof in the beginning of the Christian *Æra*.

12. Having thus found the ☉ middle motion, the motion of the *Aphelion* and fixed Stars, with their places, in the beginning of the Christian *Æra*; we will now set down the numbers here exhibited *Æra Christi*. Mr. *Wing* from the like observations, takes the ☉ motion to be as followeth.

The ☉ mean Longitude	9.8.00.31
Place of *Aphelion*	2.8.20.03
The Anomaly	06.29.40.28

The which in decimal Numbers are

The ☉ mean Longitude	77.22460.86419
Place of the *Aphelion*	18.98171.29629
The Anomaly	58.24289.56790

The mean motions for one year.

The ☉ mean Longitude	99.93364.37563.34
The *Aphelion*	00.00475.04447.05
The ☉ mean Anomaly	99.92889.33116.29

The ☉ mean motions for one day.

The

The ☉ mean Longitude	00.27379.08048.11
The *Aphelion*	00.00001.30149.17
The mean Anomaly	00.27377.77898.94

And according to these measures are the Tables made shewing the ☉ mean Longitude and Anomaly, for Years, Months, Days and Hours.

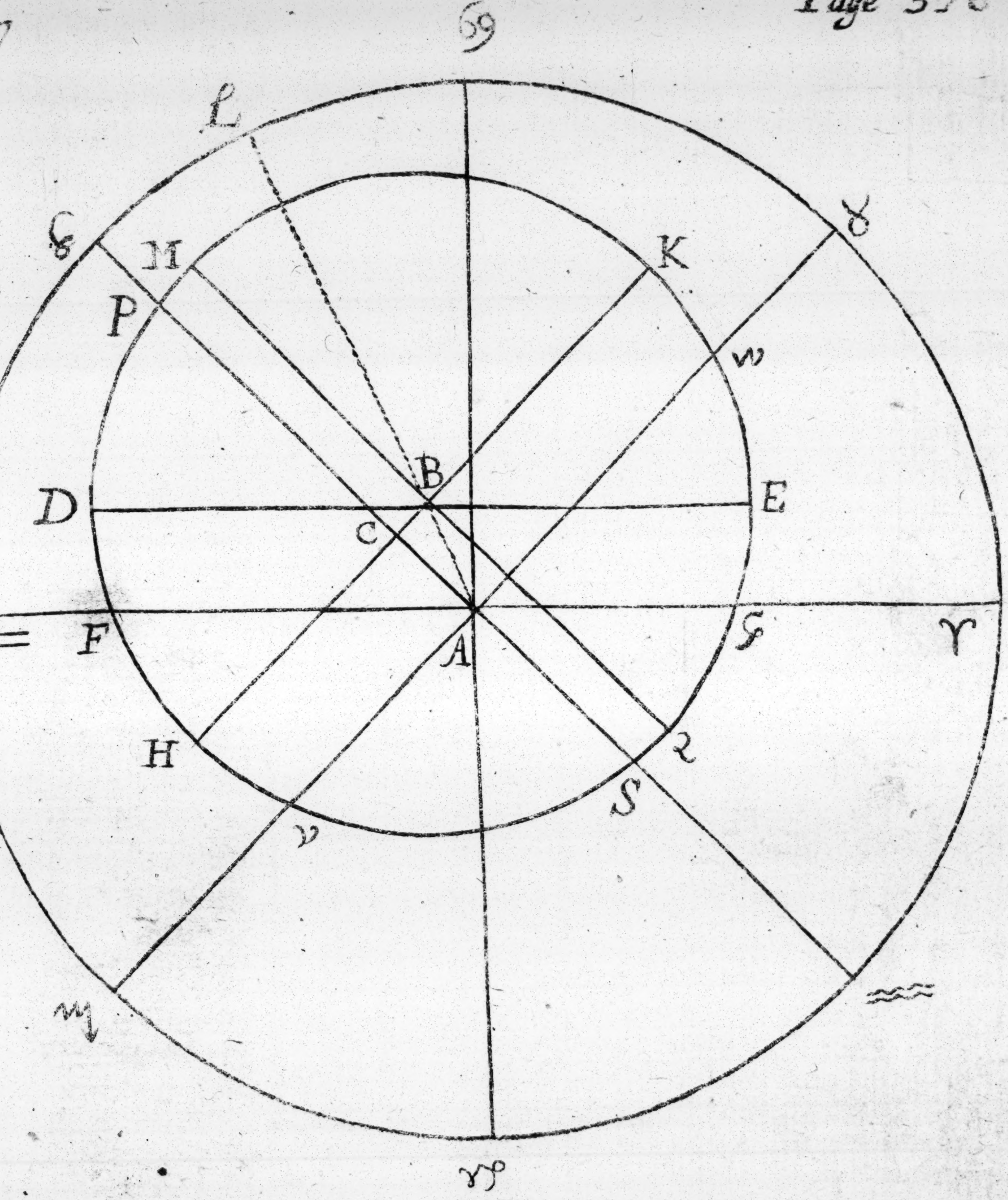
CHAP. XII.

The Suns mean motions otherwise stated.

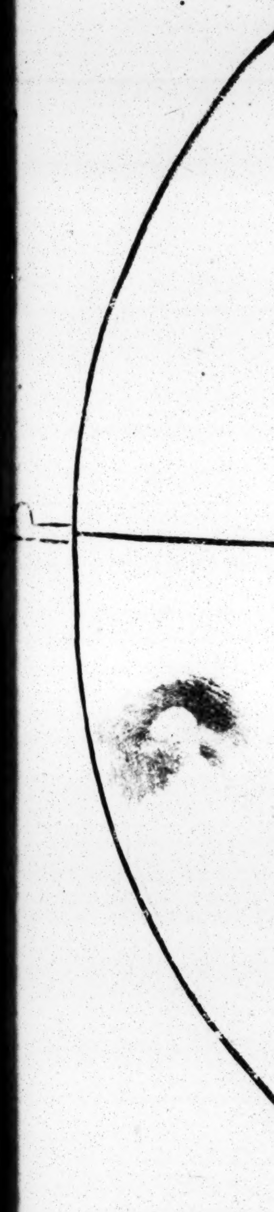
SOme there are in our present age, that will not allow the *Aphelion* to have any motion, or alteration, but what proceeds from the motion of the fixed Stars, the which as hath been shewed, do move 50 seconds in a year, and hence the place of the first Star in Aries, in the beginning of the Christian *Æra* was found to be ♈. 5.23$^{d.}$40.

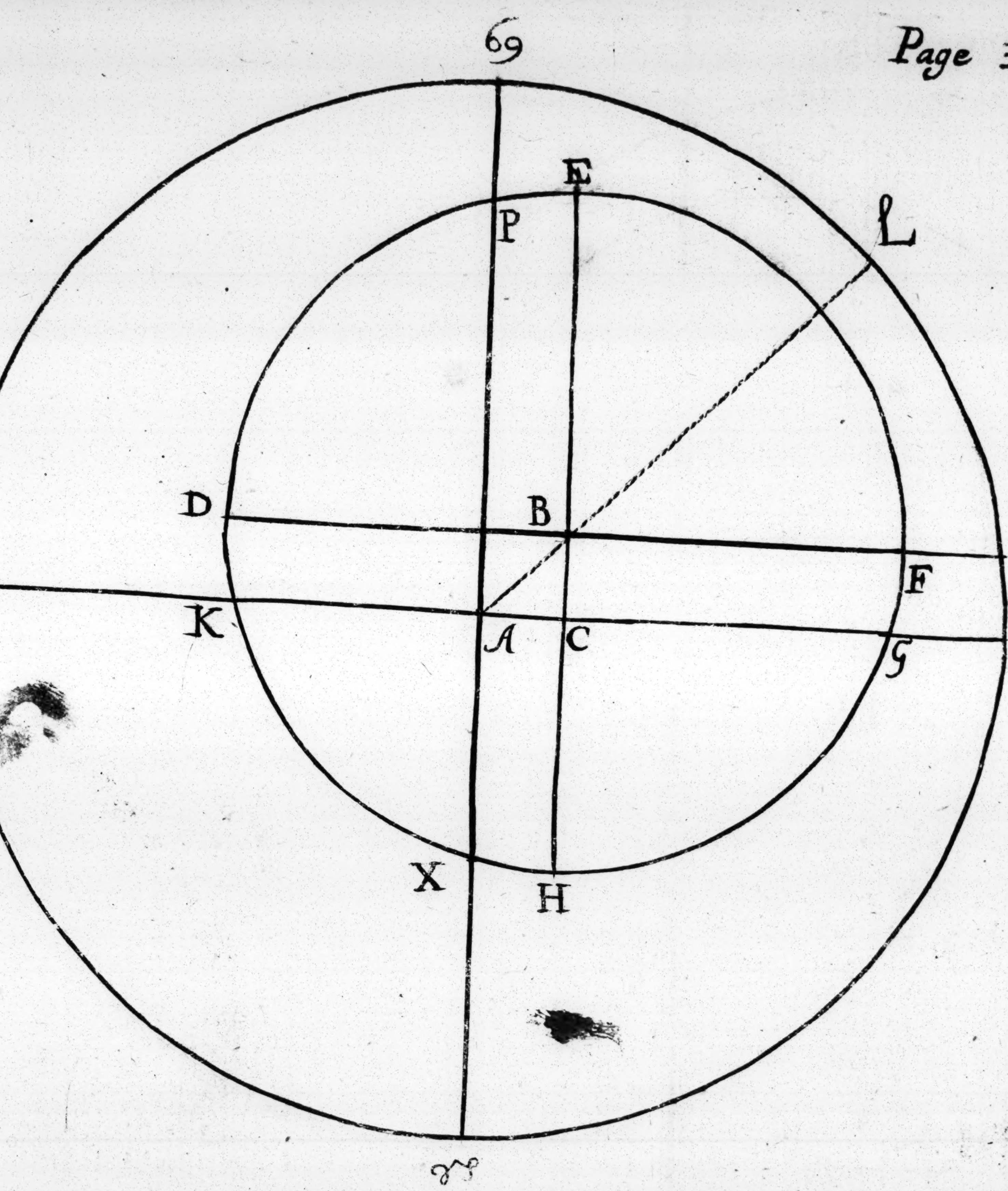
Now then, if from the place of the *Aphelion Anno Christi.* 1652 as was shewed in the tenth Chapter, deg. 96. 33′. 39. we deduct the motion of the fixed Stars for that time. 28. 19. 12. the remainer 68. 14. 27 is the constant place of the *Aphelion*; but Mr. *Street* in his *Astronomia Carolina* Page 23, makes the constant place of the *Aphelion* to be 68$^{d.}$ 20.00, and the ☉ excentricity 1732.

And from the observation of *Tycho* 1590 *March* the eleventh. in the Meridian of *Vraniburg*, but reduced to the Meridian of *London*. *March* the tenth, hour 23. 2′. He determines


L
M
K
P
w
B
D
E
C
F
A
H
S
v

6




♋
E
P
L
D
B
F
K
A
C
G
♈
X
H
♑

det

Th
Th

Th
Æ

Th
Eſt
A

Th
Th
Pr

Pl
Bu
T
W
to
T
T
T
A

2
w
ſe
6
t
t

determines the Earths mean Anomaly thus.

The place of the Sun observed	♈. 0. 33. 19
The præcession of Æquinox	0.27.27.22
The Earths Sydereal Longitude	5.03.05.57
The place of the *Aphelion* Subtract	8.08.20.00
The Earths true Anomaly	8.24.45.57
Æquation Subtract	1.58.47
The remainer is the Estimate M. Anom.	8.22.47.10
Æquation answering thereto add.	1.58.27
The Earths true Anomaly	8.24.45.37
The place of the *Aphelion*	8.08.20.00
Præcession of the Æquinox	0.27.27.22
Place of the Sun	♈.00.32.59
But the place by observation	♈.00.33.19
The difference is	001.001.20
Which being added to the mean Anom.	8.22.47.10
The mean Anomaly is	8.22.47.30
The absolute Æquation	1.58.27
The true Anomaly Agreeing with observation.	8.24.45.57

And so the mean Anomaly *Æra Christi* is 6. 23. 19. 56. But Mr. *Flamsted* according to whose measure the ensuing Tables are composed, takes the mean Anomaly *Æra Christi*. to be 6. 24. 07. 091. The place of the *Aphelion* to be 8, 08. 23. 50. And so the Præcession of the Æquinox and *Aphelion* in the beginning of

the

the Christian *Æra*. 8, 13. 47. 30. in decimal Numbers.

Æra Christi.

The Suns mean Anomaly	56.69976.85185
The Suns *Apogaeon* and Præc. Æq.	20.49768.51851

The ☉ mean motions for one Year.

The ☉ mean Longitude	99.93364.37563.34
The Præcession of Æquin.	.00385.80246.91
The ☉ mean Anomal.	99-92978.57316.43

The ☉ mean Motions for one Day.

The ☉ mean Longitude	00.27379.08048.11
The Præcession of Æqui.	00.00001.05699.30
The ☉ mean Anom.	00.27378.02348.81

CHAP. XIII.

How to Calculate the Suns true place by either of the Tables of middle motion.

VVRite out the *Epocha* next before the given time, and severally under that set the motions belonging to the years, months and days compleat, to the hours, scruples, current every one under his like (only remember that in the Bissextile years after the end of *Frebruary* the days must be increased by an unite) then adding all together, the sum shall be the ☉ mean motion for the time given.

Example

Example.

Let the given time be *Anno Christi* 1672. *February* 23. hours 11. 34′. 54″. by the Tables of the ⊙ mean Longitude and Anomaly, the numbers are as followeth.

		M. Longitud.	M. Anomal.
The *Epocha*	1660	80.67440.	53.79815
Years	11	99.81766.	99.76526
January		08.48751.	08.48711
Day.	23	06.29718.	06.29688
Hours	11	00.12548.	00.12548
	34	00.00646.	00.00646
	54	00.00017.	00.00017
		95.40886.	68.47951
		68.45882.	
		26.95004	

By the Tables of the Suns mean Anomaly and præcession of the Æquinox, the numbers are these.

		Anomaly.	Præce.Æqui.
The *Epocha*	1660	53.76721.	26.90200
Years	11	99.77520.	00.04243
January		8.48718.	00032
Days	23	6.29694.	00024
Hours	11	0.12548.	26.94499
	34′	.00646.	68.45882
	54″	.00035.	95.40381

⊙ mean Anomaly 68.45882

There

There is no great difference between the ☉ mean Longitude and Anomaly found by the Tables of mean Longitude and Anomaly, and that found by the Tables of mean Anomaly and Precession of the Æquinox. The method of finding the Elliptical Æquation is the same in both, we will instance in the latter only, in which the ☉ mean Anomaly is Degrees 68. 45882. And the precession of Æquin. deg. 26. 94499.

But because there is no Canon of Sines and Tangents as yet published, suitable to this division of the Circle into an 100 deg. or parts: We must first convert the ☉ mean Anomaly, and prec. of of the Æquin. given, into the degrees and parts of the common Circle: And this may be done either into degrees and decimal parts of a degree, or into deg. and minutes: if it were required to be done into degrees and minutes, the Table here exhibited for that purpose will serve the turn, but if it be required to be done into degrees and decimal parts, I judge the following method to be more convenient.

Multiply the degrees and parts given by 36, the Product, if you cut off one figure more towards the right hand than there are parts in the number given, shall be the degrees and parts of the common Circle.

Anomaly.	68.45882	Præc.Æquinox.	26.94499
	36		36
	41075292		16166994
	20537646		8083497
Anom.	246.451752	Præ.Æq.	97.001964

And

And if you multiply the parts of these Products, you will convert them into minutes.

Otherwise thus. Multiply the degrees and parts given by 6 continually, the second Product, if you cut off one figure more towards the right hand than are parts in the number given, shall be the degrees and parts of the common Circle. The third Product of the parts only shall give minutes, the fourth seconds, and so forward as far as you please. Example.

☉ Mean Anom. 68.45882	Præc. Æq. 26.94499
6	6
41075292	16166994
246.451752	97.001964
6	6
27.10512	0.11784
6	6
6.3072	7.0704

And thus the mean Anom. is deg. 246.451742 or 27′.06. The Prec. Æq. 97.001964. or 00′.07″.

Hence to find the Elliptical Æquation in degrees and decimal parts: In Fig. 8. we have given in the right lined plain Triangle *EMH*, the sides *ME*, and *MH*, and the Angle *EMH*, 66.451742. the excess of the mean Anomaly above a Semicircle, to find the Angle *MEH*.

The

The side *ME*	200000		
The side *MH*	3468		
Z cru.	203468	*Co. ar.*	4.69150389
X cru.	196532		5.29343327
$t\frac{1}{2}$ *Z* angle.	56.774129		10.18374097
$t\frac{1}{2}$ *X* angle.	55.857087		10.16867813

MEH. 0.917042 the double whereof is the Angle *MBH.* 1.834084 or Elliptick Æquation sought, which being added to the mean Anomaly and præcession of the Æquinox, because the Anomaly is more than a Semicircle, the same is the Suns true place.

.834084
60
50.045040
60
2.7024

The ☉ mean Anomaly	246.451742
The Præcession of the Æquinox	97.001964
Elliptick Æquation	1.834084
The Suns true place.	345.287790

But because the Elliptick Æquation thus found doth not so exactly agree to observation as is desired, *Bullialdus* in Chap. 3. of his Book entituled *Astronomiæ Philolaicæ fundamenta clarius explicata*, Printed at *Paris*, 1657. shews how to correct the same by an Angle applied to the *Focus* of middle motion, subtended by the part of the ordinate line, intercepted between the *Ellipsis* and the Circle circumscribing it. This Mr. *Street* maketh use of in his *Astronomia Carolina*, and this I thought not amiss to add here.

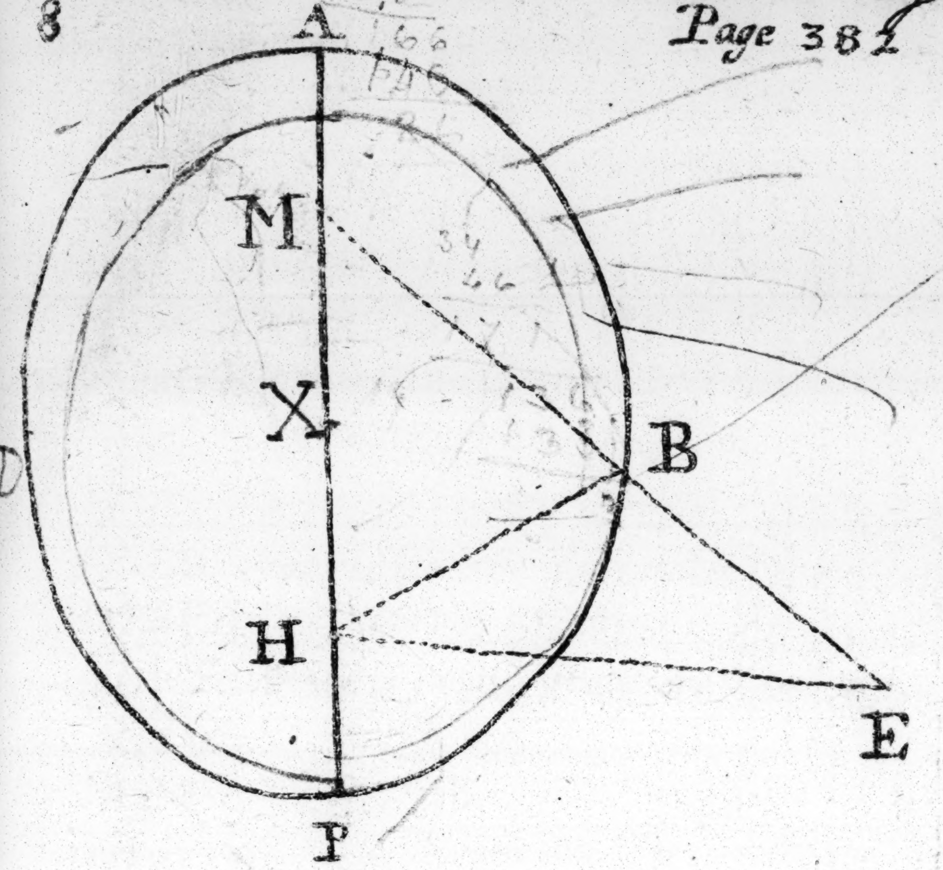
In Fig. 9. let *ABCPDF* be supposed an *Ellipsis*, and the Circle *AGPK* described upon the extremes of the transverse Diameter, and the Ordinates *KN* and *OB* extended to *G* and *M* in the

$7 \times 7 \times 4 = 282$

1713

8

Astronomy.
Page 382



1713
1058
655

C B A F E D
2 3 4 5 6

Ed Burgess

the Periphery of the Circle: then by the 21 of the first of *Apollonius*.

XN.GX::*OB tang. OEB.OM tang. OEM.*

And the Angle *OEM—OEB=BEM=ETY*, the variation to be deducted from the Elliptick Æquation *ETH*, the Remainer is the absolute Æquation *YTS* in the first Quadrant.

In the second and third Quadrants, the variation or difference between the mean and corrected Anomaly, must be added to the Elliptick Æquation, to find the true and absolute Æquation.

For *XN.XG.QV.tang.QEV.* the *comp.m.Anom. QR.t.QER.* and the Angle *VER=ECO* is the variation, and *ECO+ECH=OCH* is the absolute Æquation sought in the second Quadrant.

Again, *XN.XG*::*a D,tang.aED. a b,tang. aEB.* And *aEB—aED=DEf* the variation=*EFO* and *EfO+EfH=OfH* the absolute Æquation sought in the third Quadrant.

Lastly, in the fourth Quadrant of mean Anomaly it is.

XN.XG::*ch.tang.eEH.eg.tang.eFg.* and *hEg* is the variation: And *EFH—EFγ=YFγ* the absolute Æquation sought in the fourth Quadrant.

And to find *XN* the conjugate Semi-diameter, in the right angled Triangle *ENX*, we have given, *EN=AX* and *EX* the semi-distance of the umbilick points. And Mr. *Briggs* in Chap. 19. of his Arithm. Logar. hath shewed, that the half Sum of the Logarith. of the sum and difference of the Hypotenuse, and the given leg. shall be the Logarith. of the other leg.

+ fo ee

Now then $EN = AX$.	100000	
The Leg EX.	1734	
Their Sum	101734	5.00745001
Their difference	98266	4.99240328
The Z of the Logarithms,		9.99985329
$\frac{1}{2}$ Z. Logarith. XN.	99983	4.99992664

Now then in the former Example the mean Anomaly is 246 deg. 451741. and the exceſs above a ſemicircle is the ang. *aED*. 66.451742. Therefore.

As XN.	99983	4.99992664
Is to XG.	100000	5.00000000
So is the tang. *aED*	66.451742	10.36069857
To the tang. *aEB*	66.455296	10.36077193

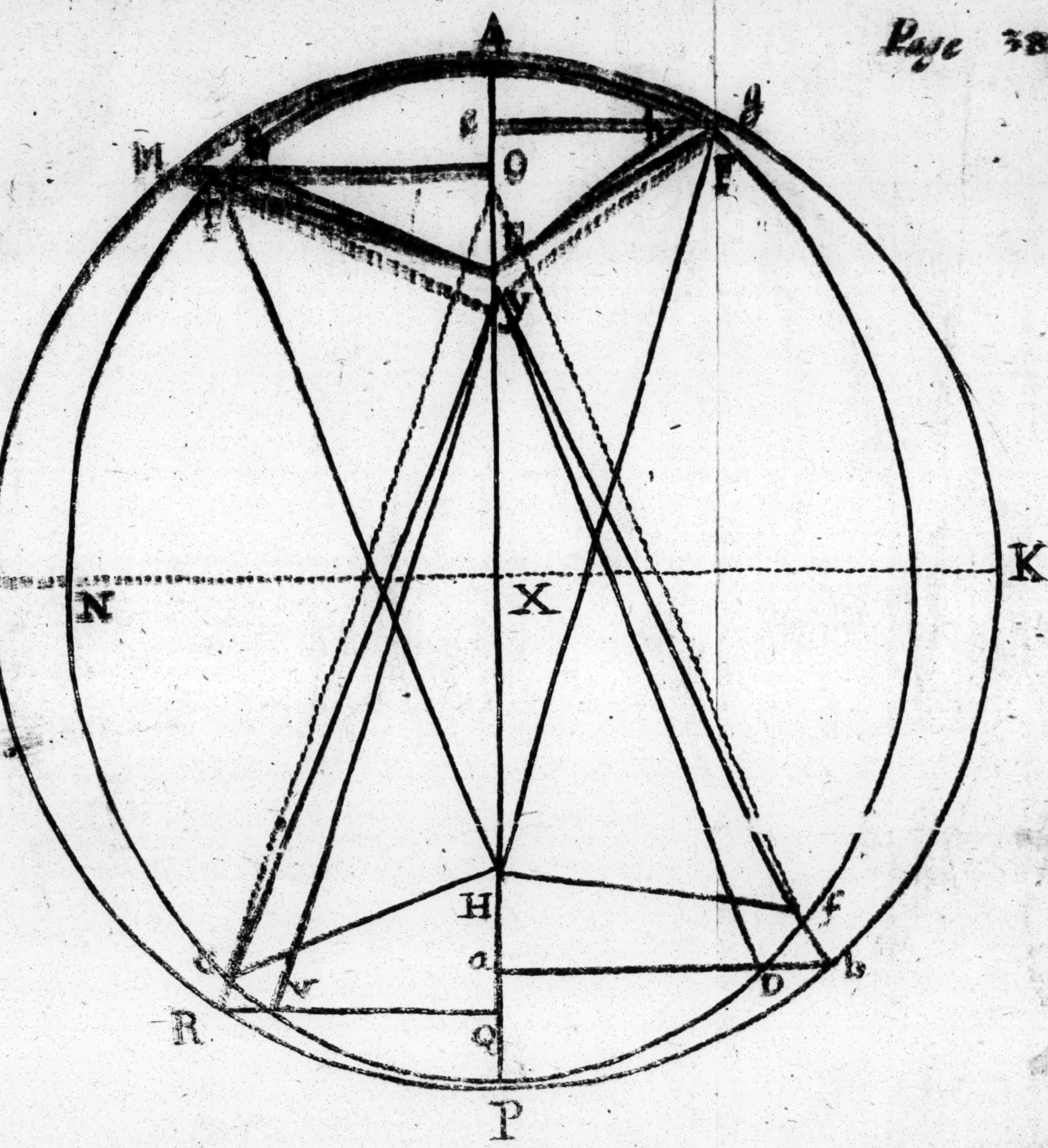
aEB—*aED*=*DEf* .003544 the variation, which being added to the Elliptick Æquation before found, the abſolute Æquation is 1.837628. and therefore the ⊙ true place 345.291334. that is ♓ 15. 17. 28.

CHAP. XIV.

To find the place of the fixed Stars.

THe annual motion of the fixed Stars is, as hath been ſhewed, 50″ Seconds, hence to find their places at any time aſſigned, we have exhibited a Table of the Longitude and Latitude of ſome of the moſt fixed Stars, from the Cata-logue

Page 384



logue of noble *Tycho* for the year of our Lord 1600 compleat. Now then the motion of the fixed Stars according to our Tables being computed, for the difference of time between 1600 and the time propounded, and subtracted from the place in the Table, when the time given is before 1600, or added to it, when the time given is after; the Summ or difference shall be the place desired. The Latitude and Magnitude are still the same.

Example. Let the given time be 1500, the difference of time is 100 years, and the motion of the fixed Stars for 100 years is 0.38580.

The place of the 1 * in ♈, 1600	7.67129
Motion for 100 years subtract	0.38580
Place required in the year 1500	7.28549

2. *Example.*

Let the time given be	1674.
The place of the first Star in ♈ 1600 was	7.67129
Motion for 60 years is	0.23148
Motion for 14 years is	0.05401
Place required in the year 1674 compl.	7.95678

CHAP. XV.

Of the Theory of the Moon, and the finding the place of her Apogæon, *quantity of excentricity and middle motion.*

THe Moon is a secondary Planet, moving about the Earth, as the Earth and other

Planets do about the Sun, and ſo not only the Earth but the whole Syſtem of the Moon, is alſo carried about the Sun in a year. And hence, according to *Hipparchus*, there ariſes a twofold, but according to *Tycho* a three-fold Inequality in the Moons Motion. The firſt is Periodical and is to be obtained after the ſame manner, as was the excentrick Æquation of the Sun or Earth: in order whereunto, we will firſt ſhew how the place of her *Apogæon* and excentricity may be found.

At *Bononia* in *Italy*, whoſe Longitude is 13 degrees Eaſtward from the Meridian of *London*, *Ricciolus* and others obſerved the apparent times of the middle of three lunar Eclipſes to be as followeth.

The firſt 1642. *April* the 4. at 14 hours and 4 Minutes.
The ſecond 1642, *September* 27 at 16 hours and 46 minutes.
The third 1643. *September* 17 at 7 hours and 31 Minutes.

The equal times reduced to the Meridian of *London*, with the places of the Sun in theſe three obſervations, according to Mr. *Street* in the 25 Page of his *Aſtronomia Carolina*, are thus.

Anno	Menſ.	D.	h.	'		d.		
1642.	*April*	4.	13.	37	♈.	25.	6.	54
1642.	*Septemb.*	27.	15.	57	♎.	14.	50.	09
1643.	*Sehtemb.*	17.	6.	46	♎.	4.	20.	20

Hence the place of the Moon in the firſt obſervation,

vation is in ♎ 25. 6′. 54. in the second ♈ 14. 50. 9. in the third ♓ 4. 20. 20. Now then in Fig. 10. let the Circle *BHDGFE* denote the Moons Æquant *T* the Center of the Earth, the Semidiameters *TD*, *TE* and *TF* the apparent places of the Moon, in the first, second and third observations, *C* the Center of the Excentrick, *CD*, *CE* and *CF* the Lines of middle motion.

From the first observation to the second there are	176$^{d.}$ 2$^{h.}$ 20′
The true motion of the Moon is deg.	169. 43. 15″
The motion of the *Apogæon* subtract	19. 37. 07
The motion of the true Anomaly is the arch *DE*	150. 06. 08
The motion of the mean Anomaly *DCE*	140. 42. 28
From the first observation to the third, there are	530$^{d.}$ 17$^{h.}$ 9.
The true motion of the Moon is degrees	159. 13. 26
The motion of the *Apogæon* subtract	159. 07. 32

The motion of the true Anomaly is the Arch *DF*	100. 05. 54
The motion of the mean Anomaly *DCF*	93. 46. 45
And deducting the Arch *DGF* from the Arch *DFE*, the remainer is the Arch *FE*	50. 00. 14
And deducting the Angle *DCF* from the Angle *DCE*, the remainer is the Angle *FCE*	46. 55. 43

Suppose 10. 00000000 the Logarithm of *DC*, continue *FC* to *H*, and with the other right Lines compleat the Diagram.

1. In the Triangle *DCH* we have given the Angle *DCH* 86. 13. 15. the complement of *DCF* 93. 46. 45 to a Semicircle. The Angle *DHC* 50. 02. 57. The half of the Arch *DF* and the side *CD* 1000000. To find *CH*.

As the Sine of *DHC* 50. 02. 57	9.88456640
To the Side *DC*, so the Sine of *HDC* 43. 43. 48.	19.83964197
To the Side *CA*	9.95507557

2 In the Triangle *HCE* we have given *CH* as before, the Angle *CHE* 25. 00. 07. The half of the Arch *FE*, the Angle *HCE* 133. 04. 17 the complement of *FCE*, and by consequence the Angle *CEH* 21. 55. 36 To find the Side *CE*.

As

As the Sine of *CEH* 21. 55. 36 9.57219707

To the Side *CH* 19.95507557
So is the Sine of *CHE* 25. 00. 07 9.62597986

19.58105543
To the Sine *CE* 10.00885836

3. In the Triangle *DCE*, we have given *DC*. *CE* and the Angle *DCE* 140. 42. 28. whose complement 39. 17. 32 is the Summ of the Angles, to find the Angle *CED* and *DE*,

As the greater Side *CE* 10.00885836
Is to the lesser Side *DC* 10.00000000
So is the *Radius* 10.00000000
To the tang. of 44. 24. 54 19.99114164

Which subtracted from 45. 2
the remainer is the half.
Difference of the acute angles 35.16.

As the Radius.

To the tang. of the com. 35. 16 8.01109962
Is to the tang. of the ½ *Z*. 19.38.46 9.55265735
To the tang. of ½ *X*. 00. 12. 35 7.56375697
Their Sum 19. 51. 21. is the angle —— *CDE*.
Their difference 19. 26. 11. is the angle *CED*.

As the Sine of *CED*. 19. 26. 11. 9.52216126
Is to the Sine of *DCE*. 140.42.28. 9.80159290
So is the Side *EC*. 10.00000000
To the Side *DE*. 10.27943164

4. In the Isosceles Triangle *DTE* we have given the Side *DE*, the angle *DTE* 150. 06. 08 whose complement 29. 53. 52 is the Summ of the other two angles, the half whereof is the angle *TDE* 14. 56. 56 which being subtracted from the angle *CDE*. 19. 51. 21 the remainer is the angle *CDT*. 4.54.25.

As the Sine of *DTE* 150.06.08 *Co. ar.* 0.30237482
Is to the Sine of *DET*. 14. 56. 56 9.41154778
So is the Side *DE* 10.27943164
To the Side *DT* 9.99335424

5. In the Triangle *CDT* we have given *DC*. *DT* and the angle *CDT*, to find *CTD* and *CT*.

As the Side *DT* 9.99335424
Is to the Side *DC* 10.00000000
So is the *Rad*. 10.00000000
To the tang. of 26. 18 10.00664576

Deduct 45.
As the *Radius*.

Is

Is to the Sine of the remainer 0. 26. 18.	7.88368672
So is the tang. of the ½ Z angle 87. 32. 57	11.36854996
To the tang. ½ X angle 10.08.04	9.25223668
Their Summ 97.41.01	is the angle *CTD*

As the Sine of *CTD*. 97.41.01. *Co. ar.*	0.00391693
Is to the Side *DC*	10.00000000
So is the Sine of *CDT* 4. 54. 25	8.93215746
To the Side *CT*	8.93607439

	s. d.
The place of the Moon in the first Observation	6.25.06.54
The true Anomaly *CTD* sub.	3.07.41.01
The place of the *Apogæon*	3.17.25.53

☾ place in the first Observation	6.25.06.54
The Æquation *CDT* Add.	04.54.25
The ☾ mean Longitude	7.00.01.19
From which subtract the place of the *Apogeon*	3.17.25.53
There rests the mean Anomaly *BCD*	3.12.35.26

And for the excentricity in such parts, as the *Radius* of the Æquant is 100000 the Proportion is.

DT.

DT	9.99335424
CT	8.93607439
100000	5.00000000
8764	3.94272015

And this is the Method for finding the place of the Moons *Apogæon* and excentricity. And from theſe and many other Eclipſes as well Solar as Lunar, Mr. *Street* limits the place of the ☾ *Apogæon* to be at the time of the firſt obſervation $21'.\ 04''$ more, and the mean Anomaly $20.\ 41''$ leſs, and the excentricity 8765 ſuch parts as the *Radius* of the Æquant is 100000.

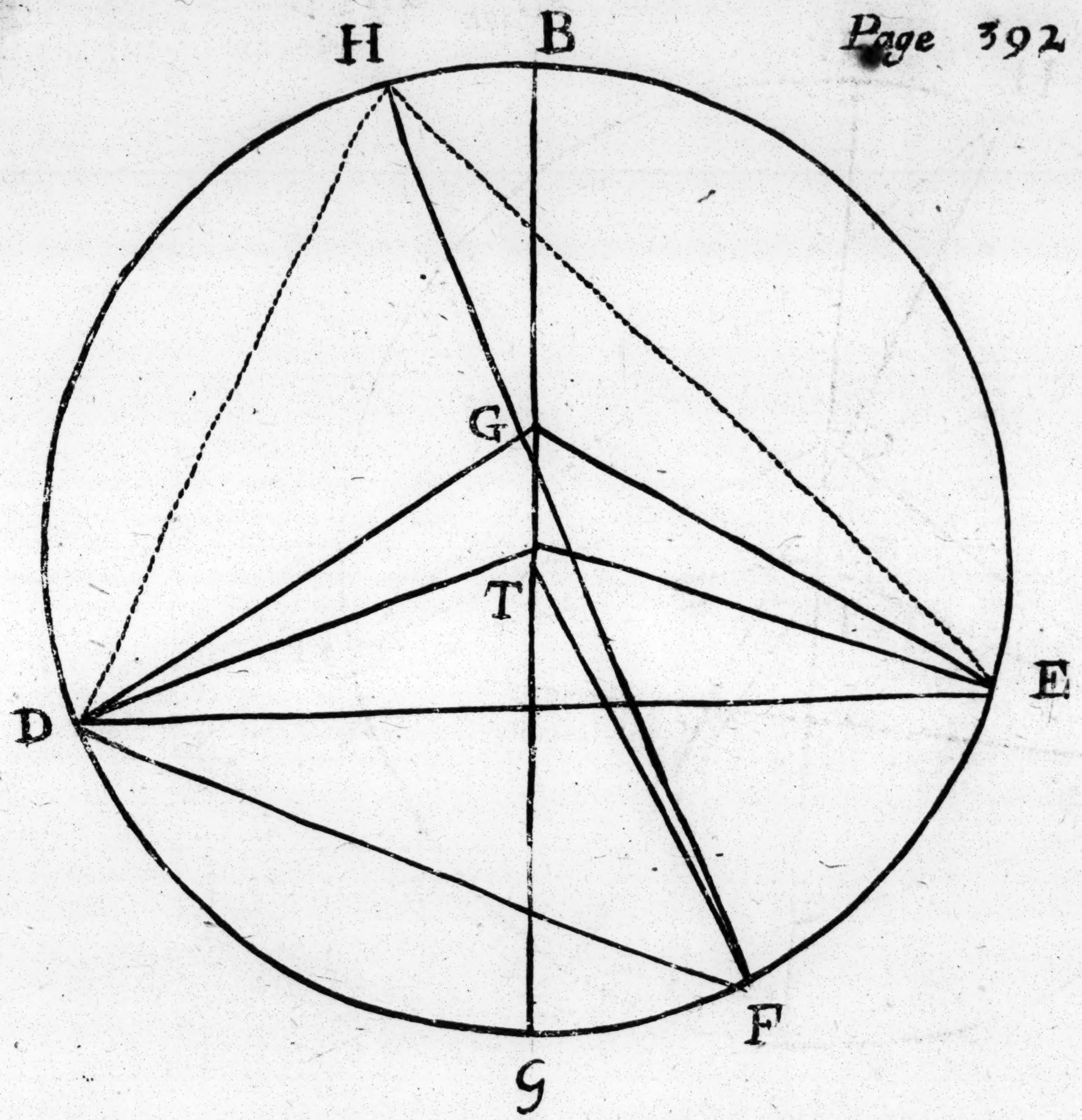
And by comparing ſundry obſervations both antient and modern, he collects the middle motion of the Moon, from her *Apogæon*, to be in the ſpace of four Julian years or 1461 days, 53 revolutions, 0 Signes, 7 degrees, 56 minutes, 45 Seconds. And the *Apogæon* from the Æquinox 5 Signes, 12 degrees, 46 minutes. And hence the daily motion of her mean Anomaly will be found to be $13^{d}.\ 03'.\ 53''.\ 57'''.\ 09^{iv}.\ 58^{v}.\ 46^{vi}.$ Of her *Apogæon* 0. 06. 41. 04. 03. 25. 33.

And according to theſe Meaſures, if you deduct the motion of the ☾ mean Anomaly for 1641 years *April*

4. hours 13. 37′, *viz.*	8. 22. 02. 00.
from	3. 121. 35. 26
The remainer is	6. 201. 33. 26

from which abating $20'.\ 41''$ the ☾ mean Anom. *Æra Chr.* 6. 20. 12. 45.

Page 392



th
w

T
T
T
is
th

—

Of

M
th
w

19
L
fo
ti

16
16

ar
30

In like manner the motion of her *Apogæon* for the same time is 6.05.311.57
which being deducted from 3.17.25.57

The remainer is 9.11.55.56
To which if you add 21.04
The Sum 91.121.15200
is the place of the ☾ *Apogæon* in the beginning of the Christian *Æra*.

CHAP. XVI.

Of the finding of the place and motion of the Moons Nodes.

A*Nno Christi* 1652, *March* 28, hour. 22.16′, the Sun and Moon being in conjunction, Mr. *Street* in Page 33, computes the ☾ true place in the Meridian of *London* to be in ♈. 19. 14. 18 with latitude North 46′. 15″.

And *Anno Christi* 1654 *August* 1. hour. 21. 19′. 30″ was the middle of a Solar Eclipse at *London*. at which time the Moons true place was found to be in ♌ 18. 58′. 12″ with North Latitude 32′. 01″.

1654 *August* 1.21. 19′. 30″ ☾ place ♌ 18. 58. 12
1652 *March* 28. 22. 16.00 ☾ place ♈ 19. 14. 18

From the first Observation to the second there are 27 years, 4 months, 5 days, 23 hours 03′. 30″.

Mean

Mean motion of the Nodes in that time, deg.	45.19.41
The true motion of the ☾	119.43.54
Their Summ is in Fig. 11. The angle *DPB*	165.03.35

Therefore in the oblique angled Spherical Triangle *DPB* we have given *BP*. 89. 13. 45 the complement of the Moons Latitude in the first observation 2. *PD* 89. 27. 50 the complement of the Moons Latitude in the second observation, and the angle *DPB* 165. 03. 35, whose complement to a Semicircle is *DPF* 14. 56. 25. The angle *PBD* is required.

1. *Proportion.*

As the Cotangent of *PD* 89.27.50	9.97114485
Is to the *Radius*	10.00000000
So is the Cosine of *DPF* 14.56.25	9.98506483
To the tang. of *PF* 89.26.42	12.01191998
BP 89.13.45	

Their Z is *FPB* 178.40.27. whose complement Is the Arch *FG* 1.19.33.

2. *Proportion.*

As the Sine of *FP* 89.26.42.*Co. ar.*	0.00002037
Is to the Cotang. of *DPF* 14.56.25	10.57376158
So is the Sine of *FG* 1.19.33	8.36418419
To the Cotang. of *FGD* 85.02.56	8.93796614

FGD=*PBD* inquired.

And

And in the right angled Spherical Triangle *BA*☊ right angled at *A* we have given *AB* 046′. 15″ the Latitude in the first observation, and the Angle *AB*☊ = *PBD* 85. 02. 56. to find *A*☊ the Longitude of the Moon from the ascending Node.

As the Cot. of *AB*☊ 85.02.56	8.93796614
Is to the *Radius*	10.00000000
So is the Sine of *AB* 0.46′.15″	8.12882290
To the tang. of *A*☊ 8.49.17	9.19085676

2. *To find the Angle* A☊B.

As the tang. of *AB* 0.46.15	8.12886212
Is to the *Radius*	10.00000000
So is the Sine of *A*☊ 8.49.17	9.18569718
To the Cotang. of *A*☊*B* 5.0.41	11.05682506

The angle of the ☾ orbite with the Ecliptick	
The first observed place of the ☾	♈. 19.14.18
A☊ Subtract	8.49.17
There rests the true place of the ☊	♈. 10.25.01

The retrograde motion whereof in 4 Julian years or 1461 days, is by other observations found to be Sign 2. deg. 17. 22′. 06″. and therefore the daily motion deg. 0. 03′. 10″. 38‴. 11^{iv}. 35^{v}.

And the motion thereof for 1651 years, *March* 28. h. 22. 16′, *viz.* Sign 8. deg. 18. 26′. 58″ being added to the place of the Node before found Sig. 0. 10. 25: 01. Their Sum is the place thereof in the beginning of the Christian *Æra* Sign 8. deg. 28. 51′. 59″.

13
35
11.5833
38.1930
10.6365
3.177279
0.529.
5459

But

But the *Rudolphin* Tables as they are corrected by Mr. *Horron* and reduced to the Meridian of *London*, do differ a little from these measures, for according to these Tables, the Moons mean motions are.

Æra Christi.

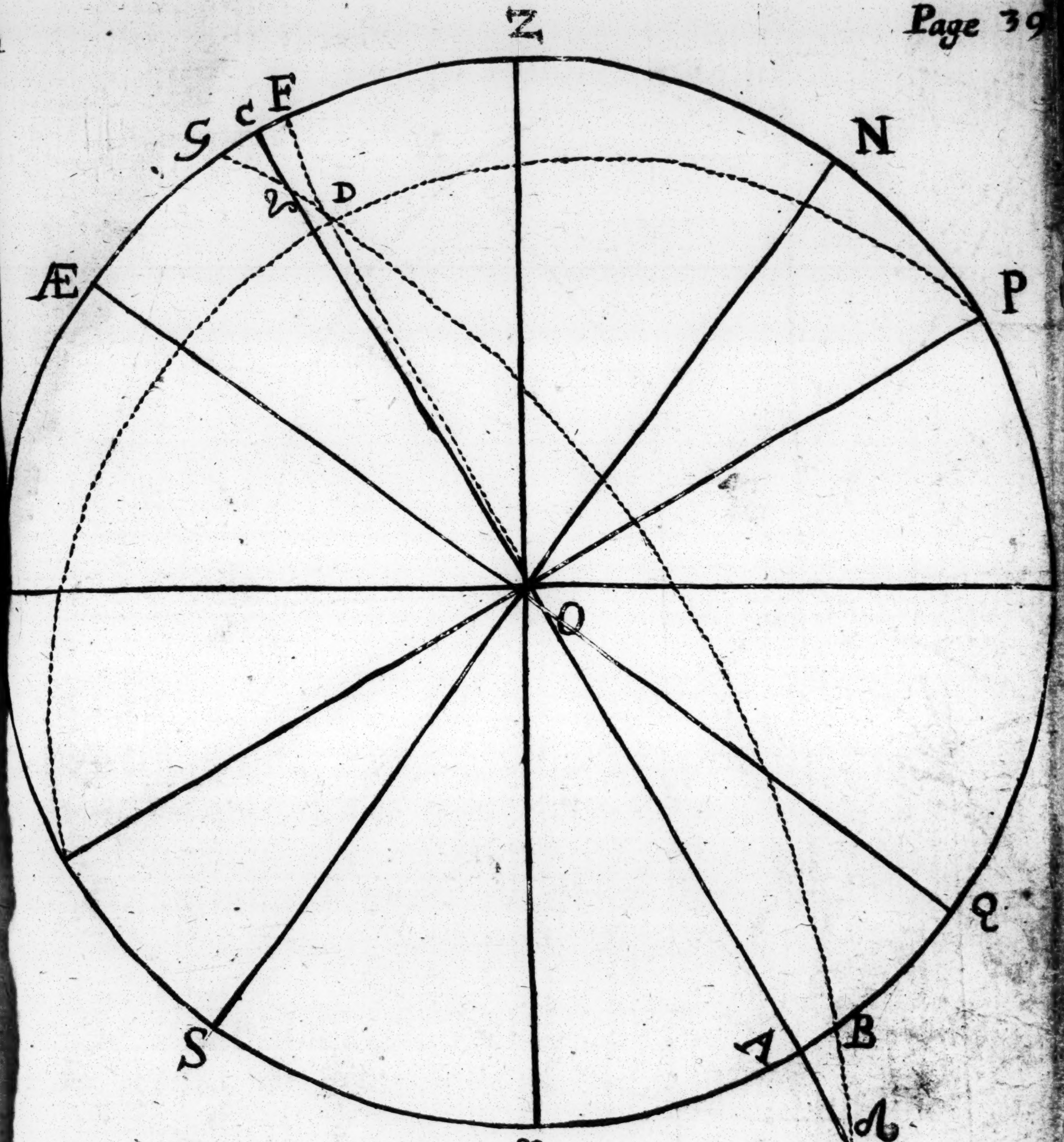
The Moons mean Longitude is	Sign.04.deg.02.25.5
The Moons *Apogæon*	Sign.09.deg.13.46.5
The Moons mean Anomaly	Sign.06.deg.18.38.5
The Moons Node Retrograde	Sign.08.deg.28.33.1

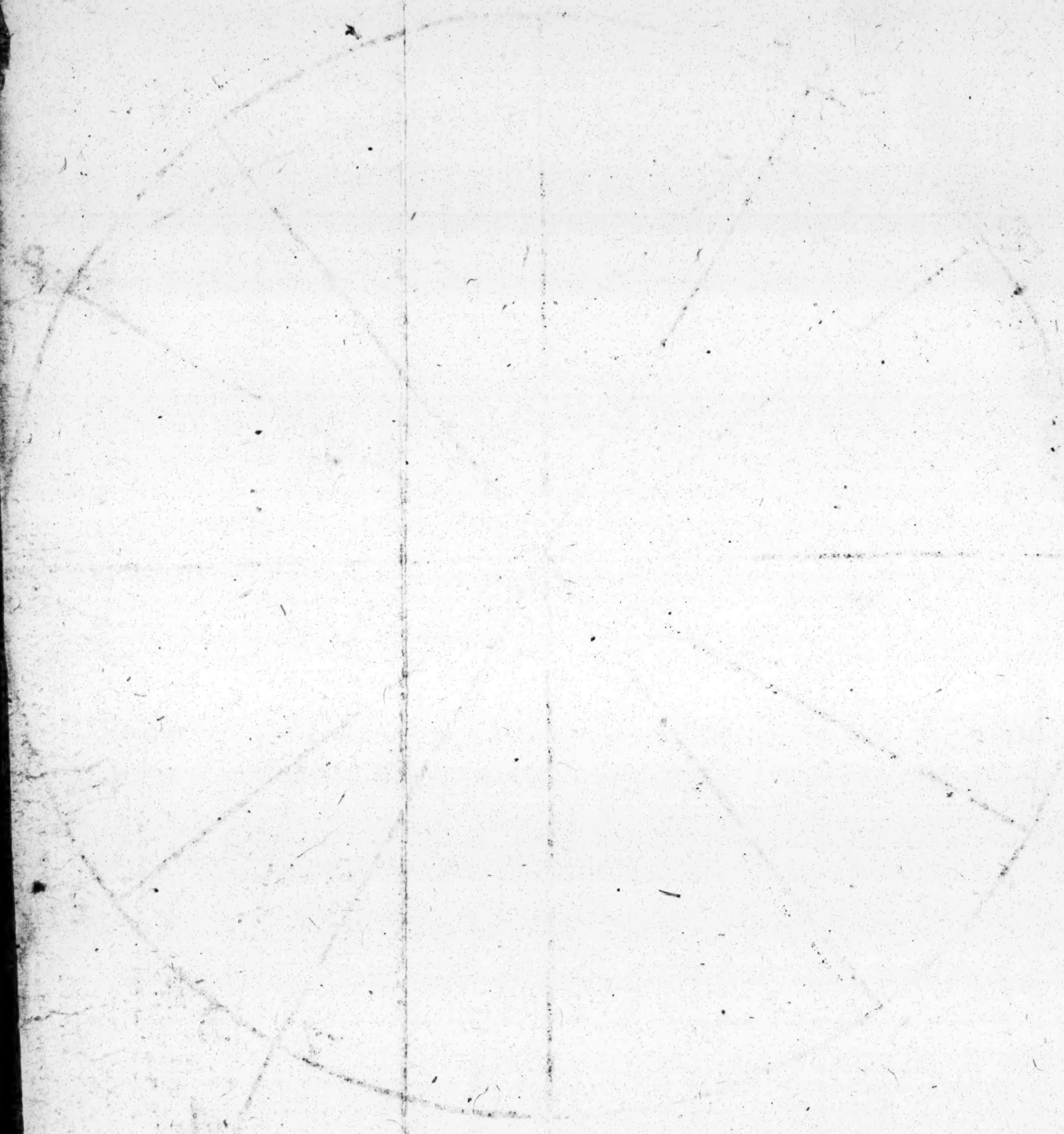
And according to these measures, the Moons mean motions in decimal Numbers are.

Æra Christi.

The Moons mean Longitude, deg.	34.00887.34567
The Moons *Apogæon*, deg.	78.82862.654320
The Moons mean Anomaly, deg.	55.18024.69135
The Moons Node Retrograde, deg.	74.69845.679010

The


Z
F
c
G
N
D
Æ
P
R
O
Q
B
A
S
n



The ☾ mean motion for one year.

The Moons mean Longitude, deg.	35.94001.44893.1
The Moons *Apogæon*, deg.	11.29551.126365
The Moons mean Anomaly, deg.	24.64450.322566
The Moons Node Retrograde, deg.	05.36900.781604

The ☾ mean motion for one day.

The Moons mean Longitude, deg	03.66010.962873
The Moons *Apogæon*, deg.	00.03094.660620
The Moons mean Anomaly, deg.	03.62916.302253
The Moons Node Retrograde, deg.	00.01470.961045

And according to theſe meaſures are the Tables made ſhewing the Moons mean Longitude, *Apogæon*, Anomaly, and Node retrograde for Years, Months, Days and Hours.

And hence to compute the Moons true place in her Orbit, I ſhall make uſe of the Method, which Mr. *Horrox* in his *Poſthumas* works laſtly publiſhed by Mr. *Flamſted*, in which from the *Rudolphin* Tables he ſets down theſe Dimenſions.

The

The Moons mean Semidiameter deg. 00.15′.30″
Her mean diſtance in Semid. of the Earth Deg. 60½ } 11.47.22
The half whereof deg. 5.53.41. he adds 45 the whole is } deg. 50.53.41
Whoſe Artificial cotangent is 9.91000022
And the double thereof makes this ſtanding Numb. } 9.82000044

The Moons	Greateſt	6685.44	Excentricity
	Mean	5523.69	
	Leaſt	4361.94	

And her greateſt variation 00. 36′. ~~27″~~ 37″.

Theſe things premiſed his directions for computing the Moons place, are as followeth.

CHAP. XVII.

How to Calculate the Moons true place in her Orbit.

TO the given time find the true place of the Sun, or his Longitude from the Vernal Æquinox, as hath been already ſhewed.

2. From the Tables of the Moons mean motions, write out the *Epocha* next before the given time, and ſeverally under that ſet the motions, belonging to the years, months and days compleat, and to the hours and ſcruples current, every one under his like (only remember that in the Biſſextile years, after the end of *February*, the days muſt be increaſed by one Unite) then adding them all together, the Summ ſhall be the

the Moons mean motions for the time given: But in her Node Retragrade you must leave out the *Radix* or first number, and the Summ of the remainer being deducted from the *Radix*, shall be the mean place of her Node required.

3. Deduct the Moons *Apogæon* from the ☉ true place, the rest is the annual Augment, the tangent of whose Complement 180 or 360, being added to the artificial Number given 9.82000044. the Summ shall be the tangent of an Arch, which being deducted from the said Complement, giveth the *Apogæon* Æquation to be added to the mean *Apogæon*, in the first and third quadrants of the annual Augment, and Subtracted in the second and fourth, their Summ or difference is the true *Apogæon*.

4. The true *Apogæon* being Deducted from the ☾ mean Longitude gives the Moons mean Anomaly.

5. Double the annual Augment, and to the Cosine thereof add the Logarithm of 1161.75. the difference between the Moons mean and extream Excentricity, *viz.* 3. 06511268, the Summ shall be the Logarithm of a number which being added to the mean Excentricity, if the double annual Augment be in the first or fourth quadrants; or Subtracted from it, if in the second or third quadrants; the Summ or difference shall be the Moons true Excentricity.

6. The Moons true Excentricity being taken for a natural Sine, the Arch answering thereto shall be the ☾ greatest Physical Æquation.

7. To the half of the Moons greatest Physical Æquation add 45 deg. the cotagent of the Summ is the artificial Logarithm of the Excentrick.

To the double whereof if you add the tang. of half the mean Anomaly, the Summ ſhall be the tangent of an Arch, which being added to half the mean Anomaly, ſhall give the Excentrick Anomaly.

8. To the Logarithm of the Excentrick, add the tangent of half the Excentrick Anomaly, the Summ ſhall be the tangent of an Arch, whoſe double ſhall be the Coequated Anomaly, and the difference between this and the mean Anomaly is the terreſtrial Equation, which being added to the Moons mean Longitude, if the mean Anomaly be in the firſt Semicircle, or Subtracted from it, if in the latter, the Summ or difference ſhall be the place of the Moon firſt Equated.

9. From the place of the Moon firſt Equated, Deduct the true place of the Sun, and double the remainer, and to the Sine of the double add the Sine of the greateſt variation 0. 36. 27, *viz.* 8. 02541571, the Summ ſhall be the Sine of the true variation, at that time, which being added to the Moons place firſt Equated, when her ſingle diſtance from the Sun is in the firſt or third quadrants, or Subtracted when in the ſecond or fourth, the Summ or difference ſhall be the Moons true place in her Orbit.

Example.

Let the given time be *Anno Chriſti* 1672. *Feb.* 23. h. 11. 34′. 54″ at which time the Suns true place is in ♓ 15. 29 13 34, and the Moons middle motions are as followeth.

☾ Long.

	☾ Longitude	☾ Apogæon	☊ Retrograde
1660.	13.36650.	41.78372.	55.85177
11.	02.66032.	24.31246.	59.08943
January.	13.46339.	00.95934	.45599
D. 23	84.18252.	.71177	.33832
H. 11	1.67755.	.01418	.00674
34′	.08641.	.00072	.00054
54	.00228.	.00012	.00001
☾ *Longitude*	15.43897.	67.78229	59.89082
			95.96094

15.43897

These Numbers reduced to the Degrees and Parts of the common Circle are for the ☾ mean Longitude. 55.580292
The ☾ *Apogæon.* 244.015956

The ☉ true place is 345.29133
The ☾ *Apogæon* subtract. 244.01595

The Annual Augment. 101.27538
The Complement whereof is 78.72462

The Tang. of deg. 78.72462 10.70033391
The standing Number. 9.82000044
The Tang. of deg. 73.20288 10.52033435
Their difference. 5.52174 the *Apogæon* Equation.
Mean *Apogæon* 244.01595
Their difference 238.49421 is the true *Apogæon.*

Secondly.

The ☾ mean Longitude.	55. 58029
The true *Apogæon* ſubtract.	238. 49421
Reſts the ☾ mean *Anom.* correct.	177. 08608

Or thus.

The ☾ mean Anomaly in the Tables for the time propounded, will be found to be (67. 78221,) which converted into the deg. and parts of the common Circle is 171. 56434
To which the *Apogæon* Equation being added } 5. 52174
Their Sum is the mean *Anom.* correct. 177. 08608

And hence it appears that working by the mean Anomaly inſtead of the mean Longitude, the true *Apogæon* Equation muſt be added to the mean Anomaly, in the ſecond and fourth Quadrants of the ☾ Annual Augment, and ſubtracted from it in the firſt and third.

Thirdly.

The Annual Augment. 101. 27538 being doubled is deg. 202. 55076, the Coſine of whoſe exceſs above 180, that is the Coſine of 22. 54076 is 9. 96545577
The Logarithm of 1161. 75 3. 06511268
The Logarithm of 1072. 92 3. 03056845
The ☾ mean Excentr. 5523. 69
Their difference 4450. 77 is the ☾ true Excentricity

centricity. Which taken as a natural Sine, the Arch answering thereunto Deg. 2.55094 is the ☾ greatest Physical Equation.

Fourthly.

To the half of the Physical Equation. deg. 01. 27547 add 45 degrees, the Sum is deg. 46.27547, the Cotangent whereof; *viz.* 9.98080957 is the Logarithm of the Excentrick, the double of which Logarithm is 9.96161914

Tangent ½ Anomaly corrected 88.54304		11.59455229
Tang. of deg.	88.40849	11.55620143

Their Sum deg. 176.95153 is the excentrick Anomaly.

Fifthly.

The Logarithm of the Excentrick is		9.98080957
Tang. ½ excent. Anom.	88.475765	11.57505878
Tangent of deg.	88.407268	11.55866835
The double whereof	176.814536	is the coequated Anomaly.
M. Anomaly correct.	177.086080	
Their difference	0.271544	is the Equation sought to
be subst. from ☾ mean Long.	55.580292	
The Remainer	55.308748	is the ☾ place first Equated.

Sixthly.

From the place of the ☾ first Equated.	55.308748
Deduct the true place of the Sun	345.291330
The Remainer is the Distance of the ☾ *à* ☉.	70.017418

The double whereof is 140.034836. The Sine of whose Complement to a Semi-circle, 39.965164 is 9.80775260

The Sine of the greatest variation	8.02541571
The Sine of the true var. 0.390206	7.83316831

The ☾ place first Equa. 55.308748

The ☾ place in Orbit 55.698954 that is in Sexagenary Numbers. 8.25.41.54.

CHAP. XVIII.

To compute the true Latitude of the Moon, and to reduce her place, from her Orbit to the Ecliptick.

THe greatest Obliquity of the Moon's Orb with the Ecliptick or Angle *A☊B Fig.* 11. is by many Observations confirmed to be 5 Degrees just, at the time of the Conjunction or Opposition of the Sun and Moon, but in her Quarters deg. 5.18′. Now then to find her Latitude at all times, the said Mr. *Horrox* refers us to *pag.* 87. in the *Rudolphin* Tables, to find from thence the Equation of the Nodes, and Inclination *limitis menstrui*, in this manner.

1. From the mean place of the Node, deduct

Jer. Horrox born 1619 died 1640-41 aged 22. the

the ☉ true place, the Remainer is the distance of the ☉ from the ☊. with which entring the said Table, he finds the Equation of the Node and Inclination *limitis menstrui*, which being added to or subtracted from the Nodes mean place according to the title, the Sum or difference is the true place of the Node, which being deducted from the place of the Moon in her Orb, the Remainer shall be the Augment of Latitude or Distance of the Moon from the Node, or Leg *A*☊.

2. With the Augment of Latitude, enter the Table of the Moon's Latitude, and take thence her Simple and Latitude and Increase answering to it. Then say, *as the whole excess of Latitude* 18′, *or in Decimals* 30. *is to the Inclination of the Monthly limit: So is the increase of Latitude to the Part Proportional*; which being added to the simple Latitude, will give you the true Latitude of the Moon.

3. With the same Augment of Latitude, enter the Table of Reduction, and take thence the Reduction and Inclination answering thereto: Then say again, *as* 18′.00″. *or* 0.30. *is to the Inclination of the Monethly limit: So is the increase of Reduction, to the Part Proportional*; which being added to the simple Reduction, shall give the true, to be added to, or subtracted from the place of the Moon in the Ecliptick.

Example. By the former Chapter, we found the mean motion of the Node to be 95.96094, which reduced to the Degrees and Parts of the common Circle is	345.459384
And the Suns true place to be	345.291334
Their difference is the distance ☉ *à* ☊	.168050

 with

with which entring the Table, Entituled *Tabula Æquationis Nodorum Lunæ.* I find the Node to need no Equation, and the Inclination *limitis menstrui* to be deg. 00. 30.

The place of the ☾ in her Orbit	55.698954
The Nodes true place, subtract.	345.459384
The Augment of Latitude	70.239570

2. With this Augment of Latitude I enter the Table shewing the Moons simple Latitude, and thereby find her simple Latitude to be Degrees. 04. 70476. North; And the increase 00.28234

And therefore the Moons true Latitude is deg. } 4.98610

3. With the same Augment of Latitude, I enter the Table of Reduction, and thereby find the Reduction to be 00.06955

And the increase of Reduction to be deg.	00.00855
And therefore the whole Reduction to be sub.	00.07810
From the ☾ place in her Orbit	55.69895
The ☾ true place in the Ecliptick	55.62085
That is in Sexagenary Numbers.	8.25.37′.15″.

55.69085

37.25100

15.06

CHAP.

CHAP. XIX.

To find the Mean Conjunction and Opposition of the Sun and Moon.

TO this purpose we have here exhibited a Table shewing the Moons mean motion from the Sun, the construction whereof is this: By the Tables of the Moons mean motions, her mean

Longitude *Æra Christi* is	34.0088734567
The ☉ mean Anomaly.	56.6997085185
Præcession of the Æquinox.	20.4976851851
Their Sum is the ☉ mean longit. *Æra Christi.*	77.4973937036
Which being deducted from the ☾ mean longitude, the remainer is the Moons mean	56.8114797531

distance from the Sun, in the beginning of the Christian *Æra*.

In like manner the Moons mean distance from the Sun in a year or a day is thus found.

☉ Anomaly for a year.	99.9297857316
Præcession of the Æquinox.	0038580246
Their Sum subtract.	99.9336437562
From the ☾ mean Longitude.	35.9400144893
Moons distance from the ☉.	36.0063707331

Moons

Moons distance from the Sun in a days time.

☉ mean Anomaly.	27378.02348
Præcession of the Æquinox.	1.05699
Their Sum subtract.	27379.08047
From the ☾ mean Longitude.	03.66010.96287
☾ Daily motion from the ☉.	03.38631.88240

And according to these measures are the Tables made, shewing the Moons mean motion from the Sun, by which the mean conjunction of the ☉ and Moon may be thus computed.

To the given year and Month gather the middle motions of the Moon from the Sun, and take the complement thereof to a whole Circle, from which subtracting continually the nearest lesser middle motions, the day, hour, and minute ensuing thereto is the mean time of the Conjunction.

Example, *Anno Christi* 1676. I would know the time of the mean Conjunction or New Moon in *October*.

Epocha 1660	32.697283
Years Compl. 15.	50.254463
Septemb. Compl.	24.465038
1. day for Leap-year.	03.386318
Their Sum is the Moons motion from the ☉.	10.803102
Complement to a whole Circle.	89.196898
Days 26 Subtract.	88.044289
	1.152609
Hours 8. substract.	1.128772

Minutes

Minutes 10 Subtract.	0.023837
	0.023516
The Remainer giveth 8″.	.00321

Therefore the mean Conjunction in *October*, 1676. was the 26 day, 10 min. 8 seconds after 8 at night.

And to find the mean opposition. To the complement of the middle motion, add a semicircle, and then subtract the nearest lesser middle motions as before, the day, hour, and minute ensuing thereto, shall be the mean opposition required.

Example, *Anno Christi*, 1676. I desire to know the mean opposition in *November*.

Epocha 1660	32.697283
Years Compl. 15	50.254463
October Compl.	29.440922
1 day for Leap-year.	03.386318
The ☾ mean motion from the ☉.	15.778986
Complement to a whole Circle.	84.221014
To which add a Semicircle.	50.
The Sum is	34.221014
Days 10 subtract.	33.863188
	.357826
Hours 2.	.282193
	.075633
Minutes 32.	.075251
The Remainer giveth 9 seconds.	.000382

Therefore

Therefore the Full Moon or mean Opposition of the Sun and Moon was *November* the 10th, Hours 2, 32′ 09″. The like may be done for any other.

And here I should proceed to shew the manner of finding the true Conjunction or Opposition of the Sun and Moon, but there being no decimal Canon yet extant, suitable to the Tables of middle motions here exhibited, I chuse rather to refer my Reader to Mr. *Street*'s *Astronomia Carolina*, for instructions in that particular, and what else shall be found wanting in this Subject.

AN

James Burgess

AN INTRODUCTION TO Geography, OR, The Fourth Part of COSMOGRAPHY.

CHAP. I.

Of the Nature and Division of Geography.

GEOGRAPHY is a Science concerning the measure and distinction of the Earthly Globe, as it is a Spherical Body composed of Earth and Water, for that both these do together make but one Globe.

2. And

2. And hence the parts of Geography are two, the one concerns the Earthy part, and the other the Water.

3. The Earthy part of this Globe is commonly divided into Continents and Islands.

4. A Continent is a great quantity of Land not separated by any Sea from the rest of the World, as the whole Continent of *Europe*, *Asia*, and *Africa*, or the Continents of *France*, *Spain*, and *Germany*.

5. An Island is a part of Earth environed round about with some Sea or other; as the Isle of *Britain* with the Ocean, the Isle of *Sicily* with the Mediterranean, and therefore in Latine it is called *Insula*, because it is scituate in *Salo*, in the Sea.

6. Both these are subdivided into *Peninsula*, *Isthmus*, *Promontorium*.

7. *Peninsula*, *quasi pene insula*, is a tract of land which being almost encompassed round by water, is joyned to the main land by some little part of Earth.

8. *Isthmus* is that narrow neck of Land which joyneth the *Peninsula* to the Continent.

9. *Promontorium* is a high mountain which shooteth it self into the Sea, the outmost end whereof is called a Cape or Foreland, as *the Cape of Good Hope* in *Africk*.

10. The Watry part of this Globe may be also distinguished by diverse Names, as Seas, Rivers, Ponds, Lakes, and such like.

11. And this Terrestrial Globe may be measured either in whole, or in any particular part.

12. The measure of this Earthly Globe in whole, is either in respect of its circumference, ro its bulk and thickness.

13. For

13. For the measuring of the Earths circumference, it is supposed to be compassed with a great Circle, and this Circle in imitation of Astronomers, is divided into 360 degrees or parts, and each degree is supposed to be equal to 15 common German miles, or 60 miles with us in *England*, and hence the circumference of the Earth is found, by multiplying 360 by 15, to be 5400 German miles, or multiplying 360 by 60, the circumference is 21600 English miles.

14. The circumference of the Earth being thus obtained, the Diameter may be found by the common proportion between the Circumference and the Diameter of a Circle, the which according to *Archimedes* is as 22 to 7, or according to *Van Culen* as 1 to 3. 14159. and to bring an Unite in the first place.

As the circumference 3. 14159. is to 1 the Diameter, so is 1 the circumference to 318308 the Diameter, which being multiplied by 5400, the Earths Diameter will be found to be 1718 German miles and 8632 parts, but being multiplied by 21600, the Diameter will be 6875 English miles, and parts 4528.

15. The measure of the Earth being thus found in respect of its whole circumference and Diameter, that which is next to be considered, is the distinction of it into convenient spaces.

16. And this is either Primary or Secondary.

17. The Primary distinction of the Earthly Globe into convenient spaces, is by Circles considered absolutely in themselves, dividing the Globe into several parts without any reference to one another.

18. And

18. And theſe as in the Celeſtial Globe, are either great or ſmall.

19. The Great Circles are ſuch, as divide the whole Globe into two Equal Parts or Spaces, and are either more or leſs Principal.

20. The principal great Circles are ſuch as have a principal or chief uſe in dividing the Globe into its Parts, and are either fixed or moveable.

21. There is but one fixed or immutable great Circle in the Terreſtrial Globe, keeping one and the ſame place, and without any Multiplication, by reaſon of the variety of places upon the Earth, and this is called the *Æquator*.

22. The *Æquator* is a great Circle going round about the Terreſtrial Globe, from Eaſt to Weſt. The uſe is to ſhew the Latitude or Diſtance of any Town or Place from thence towards the North or South Pole, and muſt be meaſured by the Degrees in the Meridian.

23. The mutable great Circles are two, the Meridian and the Horizon.

24. The Meridian Circle, is a great Circle drawn from Pole to Pole, or through the North or South Points of every place; ſo that there are as many Meridians as there are diſtinct places upon the Earth; but the chief and firſt Meridian was by the Greeks, and by the Ancients before them placed in the Fortunate Iſlands, as they were termed of old, from an opinion of ſome ſingular bleſſing imagined by the Ancients upon the *Genius* of thoſe Parts: They are now by the Spaniards called the *Canary* Iſles; whereof *Ptolemy*, and *Pliny* out of *Juba* the African King, findeth to be but ſix; but the late Diſcoverers meet with

ſeven,

ſeven, that is, *Lancerotta*, *Forteventura*, *Teneriffa*, *Gomera*, *Fierro*, *Patma*, and the *Gran Canary*; which giveth name to the reſt: for the Scituation of theſe Iſlands, they lie not as *Ptolemy* placed them within one Degree of Longitude, or little leſs, but more ſcattering, and lifted up a little above the Tropick of *Cancer*, about the thirtieth Degree of the Northern Latitude, in that part of the Weſtern otherwiſe called the Atlantick Ocean, which lieth upon the coaſt of *Africk*, and are therefore by Geographers reckoned among the African Iſles. This was the fartheſt Part of the Earth diſcovered towards the Weſt to thoſe of about *Ptolemy*'s time: therefore the great Meridian was fixed there, in the Iſle *Hera*; or *Junonea*, as then it was called; now *Teneriff*: and from this Meridian all the Longitudes in the Greek Geography are taken.

Our own Geographers, the later eſpecially have affected to tranſplant this great Meridian out of the Canary Iſles into the *Azores*, or otherwiſe termed the Flemiſh Iſles, becauſe ſome of them have been famouſly poſſeſſed, and firſt diſcovered by them. They are now in number nine: *Tercera*, S. *Michael*, S. *Mary*, S. *George*, *Gratioſa*, *Pico*, *Fayall*, *Corvo*, *Flores*, they are ſituate in the ſame Atlantick Ocean, but North-Weſt of the *Canaries*, and bending more upon the Spaniſh Coaſt, under the 39 Degree of Latitude or thereabout. Through theſe Iſles the late Geographers will have the great Meridian to paſs, ſome of them in the Iſles *Corvo*, and *Flores*, the moſt Weſtern; as *Johnſon* in his leſſer Globe of the year 1602. others in S. *Michael* and S. *Mary*, the more Eaſtern of the *Azores*, but *Stevinus* a

Dutch Geographer inclines much to the bringing back the great Meridian to the Fortunate Islands, more particularly to the Peak a Mountain so called from the sharpness in the top, in the Isle *Teneriff*, which is believed to be the highest Mountain in the World; therefore the same *Johnson* in his greatest Globe of the year 1616, hath drawn the great Meridian in that place, and it were to be wished, that this might be made the common and unchangeable practice.

25. The Horizon is a great Circle, designing so great a Part of the Earth, as a quick sight can discern in an open field; it is twofold Rational and Sensible.

26. The Rational Horizon is that which is supposed to pass through the Center of the Earth, and is represented by the wooden Circle in the Frame, as well of the Celestial, as the Terrestrial Globe, this Rational Horizon belongeth more to Astronomy than Geography.

27. The Sensible Horizon is that before defined, the use of it is to discern the divers risings and settings of the Stars, in divers places of the Earth, and why the days are sometimes longer, and sometimes shorter.

28. The great but less principal Circle upon the Terrestrial Globe is the Zodiack, in which the Sun doth always move. This Circle is described upon Globes and Maps for ornament sake, and to discover under what part of the Zodiack the several Nations lie.

29. The lesser Circles are those which do not divide the Terrestial Globe into two equal, but into two unequal Parts, and these by a general name are called Parallels, or Circles æquidistant from

from the Equinoctial; of which as many may be drawn, as there can Meridians, namely 180 if but to each degree, but they are usually drawn to every ten Degrees in each Quadrant from the *Æquator* to the Poles.

30. These Parallels are not of the same Magnitude, but are less and less as they are nearer and nearer to each Pole: and their use is to distinguish the Zones, Climates and Latitudes of all Countries, with the length of the Day and Night in any Part of the World.

31. Again, a Parallel is either named or unnamed.

32. An unnamed Parallel is that which is drawn with small black Circular Lines.

33. A named Parallel is that which is drawn upon the Globe with a more full ruddy and circular Line: such as are the Tropicks of *Cancer* and *Capricorn*, with the Arctick and Antarctick Circles, of which having spoken before in the general description of the Globe, there is no need of adding more concerning them now.

CHAP. II.

Of the Distinction or Dimension of the Earthly Globe by Zones and Climates.

Having shewed the primary distinction of the Globe into convenient spaces by Circles considered absolutely in themselves, we come now to consider the secondary Dimension or distinction of convenient spaces in the Globe, by the same Circles compared with one another,

and by the ſpaces contained between thoſe Circles.

2. This ſecundary Dimenſion or Diſtinction of the terreſtial Globe into Parts, is either a Zone or a Clime.

3. A *Zone* is a ſpace of the Terreſtial Globe included either between two of the leſſer nominated Circles, or between one and either Pole. They are in Number five, one over hot, two over cold, and two temperate.

4. The over hot or Torrid *Zone*, is between the two Tropicks, continually ſcorched with the preſence of the Sun.

5. The two over cold or Frigid *Zones*, are ſcituated between the two polar Circles and the very Poles, continually wanting the neighbourhood of the Sun.

6. The two temperate *Zones*, are one of them between the Tropick of *Cancer* and the Arctick Circles and the other between the Tropick of *Capricorn* and the Antarctick Circle, enjoyning an indifferency between Heat and Cold; ſo that the parts next the Torrid *Zone* are the hotter, and the parts next the Frigid *Zone* are the Colder.

7. The Inhabitants of theſe *Zones*, in reſpect of the diverſity of their noon Shadows are divided into three kinds, *Amphiſcii*, *Heteroſcii* and *Periſcii*. Thoſe that inhabit between the two Tropicks are called *Amphiſcii*, becauſe that their noon Shadows are diverſly caſt, ſometimes towards the South as when the Sun is more Northward than their vertical point, and ſometimes towards the North, as when the Sun declines Southward from the Zenith.

Thoſe

Thoſe that live between the Tropick of *Cancer* and the Arctick Circle or between the Tropick of *Capricorn* and the Antarctick Circle, are alled *Heteroſcii*, becauſe the Shado ws at noon are caſt one only way, and that either North or South. They that inhabit Northward of the Tropick of *Cancer* have their Shadows always towards the North, and they that inhabit Southward of the Tropick of *Capricorn*, have their noon Shadows always towards the South.

Thoſe that inhabit between the Poles and the Arctick or Antarctick Circles are called *Periſcii*, becauſe that their Gnomons do caſt their Shadows circulary, and the reaſon hereof is, for that the Sun is carried round about above their *Horizon* in his whole diurnal revolution.

8. The next ſecundary Dimenſion or diſtinction of the earthy Globe into convenient parts or ſpaces, is by Climes.

9. And a Clime or Climate is a ſpace of Earth conteined between three Paralells, the middlemoſt whereof divideth it into two equal parts, ſerving for the ſetting out the length and ſhortneſs of the days in every Country.

10. Theſe Climates and the Parallels by which they are conteined are none of them of equal quantity, for the firſt Clime as alſo the Parallel beginning at the Æquator is larger than the ſecond, and the ſecond is likewiſe greater than the third.

11. The Antients reckoned but ſeven Climates at the firſt, to which Number there were afterward added two more, ſo that in the firſt of theſe Numbers were comprehended fourteen parallels, but in the latter eighteen.

12. *Ptolemy* accounted the Paralells 38 each way from the Equator, that is 38 towards the North, and as many towards the South, 24 of which he reckoned by the difference of one quarter of an hour, 4 by the difference of half an hour, 4 by an whole hours difference, and 6 by a Months difference, but now the parallels being reckoned by the difference of a quarter of an hour, the Climates are 24 in Number till you come to the Latitude of 66 degrees 31 Minutes, to which are afterwards added 6 Climates more unto the Pole it self, where the Artificial day is 6 Months in length.

13. The distances of all both Climates and Parallels, together with their Latitudes from the Æquator, and difference of the quantity of the longest days, are here fully exprest in the Table following.

A Table of the Climates belonging to the three sorts of Inhabitants.

Inhabitants belonging to the several Climes	Climes	Paralells	Length of the Day	Poles Elevation	Bea of the Clime
	0	0	12. 0	0. 0	4. 18
		1	12. 15	4. 18	
	1	2	12. 30	8. 34	8. 25
Amphiscii		3	12. 45	12. 43	
	2	4	13. 0	16. 43	7. 50
		5	13. 15	20. 33	
	3	6	13. 30	23. 10	7. 3
		7	13. 45	27. 36	
	4	8	14. 0	30. 47	6. 9
		9	14. 15	33. 45	
	5	10	14. 30	36. 30	5. 17
		11	14. 45	39. 02	
	6	12	15. 0	41. 22	4. 30
		13	15. 15	43. 32	
	7	14	15. 30	45. 29	3. 48
		15	15. 45	47. 20	
	8	16	16. 0	49. 21	3. 13
		17	16. 15	50. 13	
	9	18	16. 30	51. 58	2. 44
		19	15. 45	53. 17	

	Climes	Paralells	Length of the Days	Poles Elevation	Breadth of the Clime
	10	20	17. 00	54. 29	2. 17
Heteroscii		21	17. 15	55. 34	
	11	22	17. 30	56. 37	2. 0
		23	17. 45	57. 34	
	12	24	18. 00	58. 26	1. 40
		25	18. 15	59. 14	
	13	26	18. 30	59. 59	1. 26
		27	18. 45	60. 40	
	14	28	19. 00	61. 18	1. 13
		29	19. 15	61. 53	
	15	30	19. 30	62. 25	1. 0
		31	19. 45	62. 54	
	16	32	20. 00	63. 22	0. 52
		33	20. 15	63. 46	
	17	34	20. 30	64. 06	0. 44
		35	20. 45	64. 30	
	18	36	21. 00	64. 49	0. 36
		37	21. 15	65. 06	
	19	38	21. 30	65. 21	0. 29
		39	21. 45	65. 35	
	20	40	22. 00	65. 47	0. 22
		41	22. 15	65. 57	
	21	42	22. 30	66. 00	0. 17
		43	22. 45	66. 14	

	Clime	Paralells	Length of the Day	Poles Ele-Vation	Breadth of the Clime
	22	44	23. 00	66. 20	0. 11
		45	23. 15	66. 25	
	23	46	23. 30	66. 28	0. 5
		47	23. 45	66. 30	
	24	48	24. 00	66. 31	0. 0

Periscii	Here the Climates begin to be accounted by Months, from 66. 31′ where the day is 24 hours long; unto the Pole it self, where it is 6 Months in length.	1	67. 15
		2	69. 30
		3	73. 20
		4	78. 20
		5	84. 0
		6	90. 0

14. Hitherto

14. Hitherto we have conſidered the inhabitants of the Earth in reſpect of the ſeveral Zones and Climes into which the whole Globe is divided; there is yet another diſtinction behind into which the inhabitants of the Earth are divided in reſpect of their ſite and poſition in reference to one another, and thus the inhabitants of the Earth are divided into the *Periœci*, *Antœci* and *Antipodes*.

15. The *Periœci* are ſuch as dwell in the ſame Parallel on the ſame ſide of the Æquator, how far diſtant ſoever they be Eaſt and Weſt, the ſeaſon of the year and the length of the days being to both alike, only the midnight of the one is the noon to the other.

16. The *Antœci* are ſuch as dwell under the ſame Meridian and in the ſame Latitude, or Parallel diſtance from the Æquator, the one Northward and the other Southward, the days in both places being of the ſame length, but differ in the Seaſons of the year, for when it is Summer in the one it is Winter in the other.

17. The *Antipodes* are ſuch as dwell Feet to Feet, ſo as a right Line drawn from the one unto the other, paſſeth from North to South through the Center of the World. Theſe are diſtant 180 degrees or half the compaſs of the Earth, they differ in all things, as Seaſons of the year, length of days, riſing and ſetting of the Sun and ſuch like. A matter reckoned ſo ridiculous and impoſſible in former times, that *Boniface* Arch-Biſhop of *Mentz* ſeeing a Treatiſe concerning theſe *Antipodes* written by *Virgilius* Biſhop of *Saliſburg*, and not knowing what damnable Doctrine might be couched under that

ſtrange

ſtrange Name, made complaint firſt to the Duke of *Bohemia*, and after to Pope *Zachary Anno* 745 by whom the poor Biſhop (unfortunate only in being learned in ſuch a time of Ignorance) was condemned of Hereſie, but God hath bleſt this latter age of the World with more underſtanding, whereby we clearly ſee thoſe things, which either were unknown, or but blindly gueſſed at by the Antients.

18. The ſecond part of the Terreſtial Globe is the Water which is commonly divided into theſe parts, or diſtinguiſhed by theſe Names, *Oceanus*, *Mare*, *Fretum*, *Sinus*, *Lacus* and *Flumen*.

19. And firſt *Oceanus* or the Ocean is that general Collection of all Waters, which encompaſſeth the Earth on every ſide.

20. *Mare* the Sea, is a part of the main Ocean, to which we cannot come but through ſome *Fretum* or Strait, as *Mare Mediterraneum*. And it takes it name firſt either from the adjacent Shore, as *Mare Adriaticum*, from the City of *Adria*; or ſecondly from the firſt diſcoverer, as *Mare Magellanicum*, from *Magellanus* who firſt found it, or thirdly from ſome remarkable accident, as *Mare Icarium* from the drowning of *Icarus* the Son of *Dædalus*.

21. *Fretum*, a Strait is a part of the Ocean penned within ſome narrow Bounds, and opening a way into ſome Sea, or out of ſome Sea into the Ocean, as the Strait of *Helleſpont*, *Gibralter*, &c.

22. *Lacus*, a Lake is a great body or collection of Water, which hath no viſible Intercourſe with the Sea, or influx into it; as the Lake of

Thraſy-

Thrasymene in *Italy*, and *Lacus Asphaltites*, or the dead Sea in the Land of *Canaan*.

23. *Flumen* or *Fluvius* is a water-course continually running, (whereby it differs frum *Stagnum* a standing Pool) issuing from some Spring or Lake, and emptying it self into some part of the Sea, or some other great River, the mouth or outlet of which is called *Ostium*.

And thus we have gon over those particulars both of Earth and Water, which appertain to this Science of Geography in the general; We will now proceed to a more particular Consideration of the several parts into which the Terrestial Globe is commonly divided.

CHAP. III.

Of Europe.

THe Terrestial Globe is divided into two parts, known or unknown.

2. The unknown or the parts of the World not fully discovered, are distinguished into North and South, the unknown parts of the World towards the North, are those which lie between the North part of *Europe* or *America* and the North Pole; and the unknown parts of the World toward the South, are those which ly between the South part of *America* and the South Pole.

3. The known parts of the World were antiently these three, *Europe*, *Asia* and *Africk*, to which in latter ages a fourth hath been added which is called *America*.

4. *Europe*

4. *Europe* is bounded on the North with the Northern Ocean, and on the South with the Mediterranean Sea, on the East with the River *Tanais*, and on the West with the Western Ocean, and is contained between the Tropick of *Cancer*, and the Pole Arctick, or 44 degrees as most do say, taking its beginning Southward from *Sicily* where the Pole is elevated 36 degrees, and is thence continued to 80 degrees of North Latitude, and so the whole Latitude of *Europe* is in English miles 2640, but some allow to *Europe* 45 degrees of Latitude, that is in English miles 2700.

5. The Longitude of *Europe* is reckoned from the furthest part of *Spain* and the *Atlantick* Ocean, to the River *Tanais*, which some reckon to be 60 Degrees, to one of which Degrees passing through the middle of *Europe*, they allow fifteen German miles almost, or sixty English, and so the Longitude in German miles is 900, in English 3600.

6. *Europe* though the least of all the four Quarters of the World, is yet of most renown amongst us: First, because of the temperature of the Air, and fertility of the Soil: Secondly, from the study of Arts, both ingenuous and mechanical: Thirdly, of the Roman and Greek Monarchies: Fourthly, from the purity and sincerity of the Christian Faith: Fifthly, because we dwell in it, and so give it the first place.

7. *Europe* may be considered as it stands divided into the Continent and the Islands: the Continent lying all together, containeth these Countries. 1. *Spain*. 2. *France*. 3. *Germany*. 4. *Italy*, and the *Alpes*. 5. *Belgium*. 6. *Denmark*.

mark. 7. *Swethland.* 8. *Russia.* 9. *Poland.* 10. *Hungary.* 11. *Sclavonia.* 12. *Dacia,* and 13. *Greece.* Of each of which I will give some short account; as also of the chief Islands as they are dispersed, in the Greek, Ægæan, Cretan and Ionian Seas, with those in the Adriatick, Mediterranean, and in the British and Northern Ocean.

8. Amongst these I give *Spain* the first place, as being the most Western Part of all the Continent of *Europe* environed on all sides with the Sea, except towards *France*; from which it is separated by the Pyrenæan Hills: but more particularly, it is bounded upon the North with the Cantabrian, on the West with the Atlantick Ocean, on the South with the Straits of *Gibralter*, on the East with the Mediterranean, and on the North East with the said Pyrenæan Hills. The Figure of it is compared by *Strabo* to an Oxes hide spread upon the Ground; the Neck whereof being that *Isthmus* which unites it to *France*.

9. The greatest length hereof, it reckoned at 800 miles, the breadth where it is broadest at 500, the whole Circumference 2480 Italian miles: but *Mariana* measuring the compass of it by the bendings of the Pyrenæan Hills, and the creeks and windings of the Sea, makes the full circuit of it to be 2816 miles of Italian measure.

10. It is situate in the more Southerly Part of the Northern temperate Zone, and almost in the midst of the fourth and sixth Climates; the longest day being 15 hours and a quarter in length in the most Northern Parts hereof: but in the extream South near to *Gibralter* not above fourteen,

fourteen, which Situation of this Country, rendreth the Air here very clear and calm, seldom obscured with mists and vapours, and not so much subject to Diseases as the more Northern Regions are.

11. This Continent is subdivided into the Kingdoms of *Navarr*. 2. *Biscay*. 3. *Guipuscoa*. 4. *Leon* and *Oviedo*. 5. *Gallicia*. 6. *Corduba*. 7. *Granada*. 8. *Murcia*. 9. *Toledo*. 10. *Castile*. 11. *Portugal*. 12. *Valentia*. 13. *Catalonia*. 14. *Majorca*. And 15. *Aragon*; but all of them are now united in the Monarchy of *Spain*.

12. *France* according to the present dimensions of it, is bounded on the East with a Branch of the *Alpes* which divide *Dauphine* and *Piemont*, as also with the Countries of *Savoy*, *Switzerland*, and some Parts of *Germany* and the *Netherlands*. On the West with the Aquitanick Ocean, and a Branch of the Pyrenæan Mountains which divide it from *Spain*. On the North with the English Ocean, and some Parts of *Belgium*, and on the South with the rest of the Pyrenæan Mountains, and the Mideterranean.

13. The Figure of it is almost square, each side of the Quadrature being reckoned 600 miles in length, but they that go more exactly to work upon it, make the length thereof to be 660 Italian miles, the breadth 570, the whole Circumference 2040. It is seated in the Northern temperate Zone, between the middle Parallel of the first Clime, where the longest day is 15 hours, and the middle Parallel of the eighth Clime, where the longest day is 16 hours and a half.

14. The Principal Provinces in this flourishing

ing Country, are. 1. *France* ſpecially ſo called. 2. *Champagne*. 3. *Picardy*. 4. *Normandy*. 5. *Bretagne*. 6. The Eſtates of *Angiou*. 7. *La Beauſio*. 8. *Nivernois*. 9. The Dukedom of *Bourbon*. 10. *Berry*. 11. *Poictou*. 12. *Limoſin*. 13. *Piregort*. 14. *Quercu*. 15. *Aquitain*. 16. *Languedoc*. 17. *Provence*. 18. *Daulphine*. 19. *La Breſſe*. 20. *Lionnois*. 21. The Dutchy. 22. The County of *Burgundy*. 23. The Iſlands in the Aquitanick and Gallick Ocean: Thoſe of moſt note are theſe ſix. 1. *Oleron*. 2. *Ree*. 3. *Jarſey*. 4. *Gernſey*. 5. *Sarke*. 6. *Aldernay* on the ſhores of *Normandy*, of which the four laſt are under the Kings of *England*.

15. *Italy* once the Empreſs of the greateſt part of the then known World, is compaſſed with the Adriatick, Ionian and Tyrrhenian Seas, except it be towards *France* and *Germany*, from which it is parted by the *Alpes*; ſo that it is in a manner, a *Peninſula*, or a Demi-Iſland. But more particularly it hath on the Eaſt the lower part of the *Adriatick*, and the *Ionian* Sea, by which it is divided from *Greece*; on the Weſt the River *Varus*, and ſome part of the *Alpes*, by which it is parted from *France*, on the North in ſome part the *Alpes* which divide it from *Germany*; and on the other, part of the Adriatick, which divides it from *Dalmatia*; and on the South the Tyrrhenian and Tuſcan Seas, by which it is ſeparated from the main Land of *Africa*.

16. It containeth in length from *Auguſta Pratoria*, now called *Aoſt*, at the foot of the *Alpes*, unto *Otranto* in the moſt Eaſtern Point of the Kingdom of *Naples* 1020 miles; in breadth from the

the River *Varo*, which parts it from *Provence*, to the mouth of the River *Arsia* in *Friuli*, where it is broadest, 410 miles; about *Otranto*, where it is narrowest not above 25 miles; and in the middle parts from the mouth of *Pescara* in the *Adriatick* or upper Sea to the mouth of *Tiber* in the *Tuscan* or lower Sea, 126 miles. The whole compass by Sea reckoning in the windings and turnings of the shore, comes to 3038 miles; which added to the 410 which it hath by Land, make up in all 3448 miles: but if the Coasts on each side be reckoned by a straight Line, then as *Castaldo* computes it, it comes to no more than 2550 miles.

17. The whole Country lieth under the first and sixth Climates of the Northern temperate Zone, which it wholly taketh up: so that the longest day in the most Northern Parts is 15 hours and three first parts of an hour; the longest in the Southern Parts, falling short a full hour of that length.

18. *Italy* as it stands now is divided into the Kingdoms of *Naples*, *Sicily* and *Sardinia*. 2. The Land or Patrimony of the Church. 3. The great Dukedom of *Tuscany*. 4. The Commonwealths of *Venice*, *Genoa* and *Luca*. 5. The Estates of *Lombardy*, that is the Dukedoms of 1. *Millain*. 2. *Mantua*. 3. *Modena*. 4. *Parma*. 5. *Montferrat*, and the Principality of *Piedmont*.

19. To the *Peninsula* of *Italy* belong the *Alpes*, a ridge of Hills, wherewith as with a strong and defensible Rampart *Italy* is assured against *France* and *Germany*. They are said to be five days Journey high, covered continually with Snow,

 from

from the whiteneſs whereof they took this name, it doth contain the Dukedom of *Savoy*; the Seigniory of *Geneva*; the Country of *Walliſland*, *Switzerland* and the *Griſons*.

20. *Belgium*, or the *Netherlands*, is bounded on the Eaſt with *Weſtphalin*, *Gulick*, *Cleve*, and the Land of *Triers*, Provinces of the higher *Germany*; on the Weſt with the main Ocean, which divides it from *Britain*; on the North with the River *Ems*, which parts it from *Eaſt-Friezeland*; on the South with *Picardie* and *Campagne* two French Provinces; upon the South-Eaſt with the Dukedom of *Lorrain*.

21. It is in compaſs 1000 Italian or 280 German miles, and is ſituated in the Northern temperate Zone, under the ſeventh, eighth and ninth Climates: the longeſt day in the midſt of the ſeventh Climate where it doth begin, being 16 hours, iu the beginning of the ninth Climate increaſed to 16 hours 3 quarters, or near 17 hours.

22. It containeth thoſe Provinces which in theſe later Ages were poſſeſſed by the Houſe of *Burgundy*, that is the Lordſhip of *Weſt-Friezeland*, given to the Earls of *Holland* by *Charles* the Bald; the Earldom of *Zutphen* united unto that of *Gelder* by Earl *Otho* of *Naſſau*, and finally the Eſtate of *Groening*, *Over-Yſſel*, and ſome part of *Utrecht*, by *Charles* the Fifth. As it ſtands now divided between the *Spaniards* and the States it containeth the Provinces of 1. *Flanders*. 2. *Artois*. 3. *Hainault*. 4. The Biſhoprick of *Cambray*. 5. *Namur*. 6. *Luxemburg*. 7. *Limbourg*. 8. *Luyckland*, or the Biſhoprick of *Leige*. 9. *Brabant*. 10. *Marquiſate*. 11. *Mechlin*. The reſt of the *Netherlands*

therlands which have now for ſometime withdrawn their obedience from the Kings of *Spain*, are 1. *Holland.* 2. *Zeland.* 3. *Weſt-Friezeland.* 4. *Utrecht.* 5. *Over-Yſſel.* 6. *Gelderland.* 7. *Zutphen.* 8. *Groening.*

23. *Germany* is bounded on the Eaſt with *Pruſſia*, *Poland*, and *Hungary*; on the Weſt with *France*, *Switzerland* and *Belgium*; on the North with the *Baltick* Seas, the Ocean, and ſome part of *Denmark*; on the South with the *Alps* which part it from *Italy*.

24. The length from Eaſt to Weſt, that is from the *Viſtula* or *Weiſſel* to the *Rhine*, is eſtimated at 840 Italian miles, the breadth from North to South, that is from the Ocean to the Town of *Brixen* in *Tyrol*, 740 of the ſame miles. So that the Figure of it being near a Square, it may take up 3160 miles in compaſs, or thereabouts. Situate in the Northern temperate Zone, between the middle Parallels of the ſixth and tenth Climates; the longeſt day in the moſt Southern Parts being 15 hours and an half, and in the moſt Northern 17 hours and a quarter.

25. The Principal Parts of this great Continent, are 1. *Cleveland.* 2. The Eſtates of the three ſpiritual Electors, *Colen*, *Mentz*, and *Triers*. 3. The *Palatinate* of the *Rhine*. 4. *Alſatia.* 5. *Lorrain.* 6. *Suevia* or *Schwaben.* 7. *Bavaria.* 8. *Auſtria* and its Appendices. 9. The Confederation of *Waderaw.* 10. *Franconia.* 11. *Wirtenberg.* 12. *Baden.* 13. The *Palatinate* of *Northgoia*, or the Upper *Palatinate.* 14. *Bohemia* and the Incorporate Provinces. 15. *Pomerania.* 16. *Mecklenburg.* 17. The *Marquiſate* of *Brandenburg.*

burg. 18. *Saxony*, and the Members of it. 19. The Dukedom of *Brunſwick* and *Lunenburg*. 20. The *Lantgravedom* of *Haſſia*. 21. *Weſtphalen*. 22. *Eaſt-Friezeland*.

26. *Denmark* or *Danemark*, reckoning in the Additions of the Dukedom of *Holſtein*, and the great Continent of *Norway*, with the Iſles thereof, now all united and incorporated into one Eſtate is bounded on the Eaſt with the Baltick Sea and ſome part of *Sweden*; on the Weſt with the main Weſtern Ocean; on the North-Eaſt with a part of *Sweden*; full North with the main frozen Seas; and on the South with *Germany*, from which it is divided on the South-Weſt by the River *Albis*, and on the South-Eaſt by the *Trave*; a little *Iſthmus* or neck of Land uniting it to the Continent.

27. It lieth partly in the Northern temperate Zone, and partly within the Arctick Circle; extending from the middle Parallel of the tenth Clime, or 55 degree of Latitude where it joyneth with *Germany*, as far as the 71 degree where it hath no other bound but the frozen Ocean; by which account the longeſt day in the moſt Southern Parts is 17 hours and a quarter, but in the Parts extreamly North, they have no Night for two whole Moneths, three Weeks, one Day, and about ſeven hours; as on the other ſide no day for the like quantity of time, when the Sun is moſt remote from them, in the other Tropick.

28. The whole Body of the Eſtate conſiſteth chiefly of three Members. *viz*. 1. The Dukedom

dom of *Holstein*; containing *Waggerland*, *Dilmarsh*, *Starmaria*, and *Holstein*, especially so called. 2. The Kingdom of *Denmark*; comprehending both *Juitlands*, part of *Scandia*, and the *Hemodes*, or Baltick Islands. 3. The Kingdom of *Norway* consisting of *Norway* it self, and the Islands of the Northern Ocean.

29. *Swethland* is bounded on the East with *Muscovy*, on the West with the *Doferine* Hills, which divide it from *Norway*; on the North with the great frozen Ocean spoken of before; on the South with *Denmatk*, *Liefland*, and the Baltick Sea.

30. It is situate under the same Parallels and Degrees with *Norway*, that is, from the first Parallel of the 12 Clime, where the Pole is elevated 58 degrees 26 minutes, as far as to the 71 degree of Latitude, by which account the longest day in the Southern Point is but 18 hours, whereas on the farthest North of all the Countrey, they have no Night for almost three whole Moneths together.

31. The whole Kingdom is divided into two Parts, the one lying on the East, the other on the West of the Bay or Gulf of *Bodener*, being a large and spacious branch of the *Baltick* Sea, extending from the most Southerly Point of *Gothland*, as far as to *Lapland* on the North. According to which Division we have the Provinces of 1. *Gothland*. 2. *Sweden* lying on the West side of the Gulph. 3. *Lapland* shutting it up upon the North. 4. *Bodia* or *Bodden*. 5. *Finland* on the East side thereof. 6. The *Sweedish* Islands, where it mingleth with the rest of the *Baltick* Seas.

32. *Russia* is bounded on the East by *Tartary*,

on the West with *Livonia* and *Finland*, from which it is divided by great mountains and the River *Poln*, on the North by the frozen Ocean, and some part of *Lapland*, and on the South by *Lituania* a Province of the Kingdom of *Poland*, and the Crim Tartar inhabiting on the Banks of *Palus Mæotis*, and the Euxine Sea. It standeth partly in *Europe* and partly in *Asia*, the River *Tanais* or *Don* running through it, the common boundary of those great and noted parts of the world.

33. It is scituate North within the Artick Circle so far, that the longest day in Summer will be full six months, whereas the longest day in the southern parts is but 16 hours and an half.

34. It is divided into the Provinces of 1. *Moscovy* specially so called. 2. *Snoleusio*, 3. *Mosaisky*, 4. *Plesco*, 5. *Novagrod* the great, 6. *Corelia*, 7. *Biarmia*, 8. *Petzora*, 9. *Condora*, 10. *Obdora*, 11. *Jugria*, 12. *Severia*, 13. *Permia*, 14. *Rozan*, 15. *Wiathka*, 16. *Casau*, 17. *Astracan*, 18. *Novogordia* inferiour, 19. *The Morduits* or *Mordua*, 20. *Worotime*, 21. *Tuba*, 22. *Wolodomir*, 23. *Duina*, 24. the Russian Islands.

35. *Poland* is bounded on the East with *Russia*, and the Crim-Tartar, from whom it is parted by the River *Borysthenes*; on the West with *Germany*, on the North with the Baltick Sea and some part of *Russia*, on the South with the *Carpathian* Mountains, which divide it from *Hungary*, *Transilvania*, and *Moldavia*. It is of figure round in compass 2600 miles, scituate under the 8 and 12 Climates, so that the longest day in the southern parts is but 16 hours, and about 18

hours in the parts moſt North.

36. The ſeveral Provinces of which this Kingdom doth conſiſt, are 1. *Livonia*, 2. *Samogitia*, 3. *Lituania*, 4. *Volkinia*, 5. *Podolia*, 6. *Ruſſia nigra*, 7. *Maſſovia*, 8. *Podlaſſia*, 9. *Pruſſia*, 10. *Pomerellia*, 11. *Poland* ſpecially ſo called.

37. *Hungary* is bounded on the Eaſt with *Tranſilvania* and *Walachia*, on the Weſt with *Sterria*, *Auſtria* and *Moravia*, on the North with the *Carpathian* mountains which divide it from *Poland*, and on the South with *Sclavonia*, and ſome part of *Dacia*: it extendeth in length from *Preſburg* along the *Danow* to the borders of *Tranſilvania*, for the ſpace of 300 Engliſh miles, and 190 of the ſame miles in breadth.

38. It lieth in the Northern temperate Zone, betwixt the middle parallels of the 7 and 9 Climates, ſo that the longeſt Summers day in the Southern parts is but 15 hours and an half, and not above 16 hours in the parts moſt North.

40. This Country is commonly divided into the upper *Hungary* and the lower, the upper lying on the North of the River *Danow*, the lower lying on the South of that River, comprehending all *Pannonia* inferior and part of Superior, and is now poſſeſſed by the King of *Hungary* and the Great Turk, who is Lord of the moſt part by Arms and Conqueſt.

04- *Sclavonia* is bounded on the Eaſt with *Servia*, *Macedonia* and *Epirus*, from which it is parted by the River *Drinus*, and a line drawn from thence unto the Adriatick, on the Weſt with *Carniola* in *Germany*, and *Iſtria* in the Seig-

niory of *Venice*, from which last it is divided by the River *Arsia*; on the North with *Hungary*, on the South with the Adriatick Sea.

41. It is scituate in the Northern temperate Zone, between the middle Parallels of the sixth and seventh Climates, so that the longest day in Summer is about 15 hours and an half.

42. This Country as it came at last to be divided, between the Kings of *Hungary* and the State of *Venice*; is distinguished into 1. *Windischland*, 2. *Croatia*, 3. *Bosnia*, 4. *Dalmatia*, 5. *Liburnia* or *Cantado di Zara*, and 6. The Sclavonian Islands.

43. *Dacia* is bounded on the East with the Euxine Sea and some part of *Thrace*; on the West with *Hungary* and *Sclavonia*; on the North with *Podolia*, and some other members of the Realm of *Poland*, on the South with the rest of *Thrace* and *Macedonia*.

44. It lieth on both sides of the *Danow* fronting all along the upper and the lower *Hungary*, and some part of *Sclavonia*; extended from the 7 Climate to the 10; so that the longest Summers day in the most northern parts thereof, is near 17 hours, and in the most southern 15 hours 3 quarters.

45. The several Provinces comprehended under the name of *Dacia*, are 1. *Transilvania*, 2. *Moldavia*, 3. *Walachia*, 7. *Rascia*, 5. *Servia*, 6. *Bulgaria*, the first four in old *Dacia*, on the North side of the *Danow*; the two last in new *Dacia*, on the South thereof.

45. *Greece* in the present Latitude and extent thereof, is bounded on the East with the

Propontick, Hellespont, and Ægean Seas, on the West with the Adriatick; on the North with Mount *Hæmus* which parteth it from *Bulgaria*, *Servia* and some part of *Illyricum*; and on the South with the Sea *Ionian*; so that it is in a manner a *Peninsula* or Demi-Island, environed on three sides by the Sea, on the fourth only united to the rest of *Europe*.

46. It is scituate in the northern temperate Zone, under the fifth and sixth Climates, the longest day being 15 hours.

47. In this Country formerly so famous for learning and government, the several Provinces are 1. *Peloponnesus*, 2. *Achaia*, 3. *Epirus*, 4. *Albania*, 5. *Macedon*, 6. *Thrace*, 7. The Islands of the Propontick; 8. Ægean, and 9. The Ionian Seas, and 10. finally the Isle of *Crete*.

And thus I have given you a brief description of those Countries which are comprehended in the Continent of *Europe*; the Islands in this part of the world are many; I will mention only some few. These two in the British and Northern Ocean, known by the names of *Great Britain* and *Ireland* are the most famous, to which may be added *Greenland*. In the Mediterranaen Sea you have the Islands of *Sicilia*, *Sardinia*, *Corsica* and *Crete*, which is now called *Candia* the greater and the less: As for the other Islands belonging to this part of the world, the Reader may expect a more particular description from them who have or shall write more largely of this subject: This we deem sufficient for our present purpose. Let this then suffice for the description of the first part of the World called *Europe*.

CHAP.

CHAP. IV.

Of Asia.

ASia is bound on the West with the Mediteranean and Ægæan Seas, the *Hellespont*, *Propontis*, Thracian *Bosphorus* and the Euxine Sea, the *Palus Mæotis*, the Rivers *Tanais* and *Duina*, a Line being drawn from the first of the two said Rivers unto the other, by all which it is parted from *Europe*; on the North it hath the main Scythick Ocean; but on the East the Indian Ocean, and *Mare del Eur* by which it is separated from *America*; on the South the Mediterranean, or that part of it, which is called the Carpathian Sea, washing the shoars of *Anatolia*, and the main Southern Ocean, passing along the Indian, Persian and Arabian Coasts: and finally on the south-west, the red Sea or Bay of *Arabia*, by which it is parted from *Affrick*. Environed on all sides with the Sea, or some Sea like Rivers, except a narrow *Isthmus* in the south-west, which joyns it to *Africk*, and the space of ground (whatsoever it be) between *Duina* and *Tanais*, on the North-west which unites it to *Europe*.

2. It is situated East and West, from the 52 to the 169 degree of Longitude; and North and South from the 82 degree of Latitude to the very Æquator; some of the Islands only lying on the South of that Circle: so that the longest summers day in the southern parts, is but twelve hours, but in the most northern parts hereof almost four whole Months together.

3. This

3. This Country hath heretofore been had in ſpecial honour; 1. For the creation of Man, who had his firſt making in this part of the World. 2. Becauſe in this part of it ſtood the Garden of *Eden*, which he had for the firſt place of his habitation. 3. Becauſe here flouriſhed the four firſt great Monarchies of the Aſſyrians, Babylonians, Medes and Perſians. 4. Becauſe it was the Scene of almoſt all the memorable Actions which are recorded by the penmen of the Scriptures. 5. Becauſe our Saviour Chriſt was borne here, and here wrought his moſt divine Miracles, and accompliſhed the great work of our Redemption. 6. And finally, becauſe from hence all Nations of the World had their firſt beginning, on the diſperſion which was made by the Sons of *Noah* after their vain attempt at *Babel*.

4. This part of the World for the better underſtanding of the Greek and the Roman Stories and the eſtate of the Aſſyrian, Babylonian and the Perſian Monarchies, to which the holy Scriptures do ſo much relate, we ſhall conſider as divided into the Regions of 1. *Anatolia or Aſia minor*. 2. *Cyprus*. 3. *Syria*. 4. *Arabia*. 5. *Chaldea*. 6. *Aſſyria*. 7. *Meſopotamia*. 8. *Turcomania*. 9. *Media*. 10. *Perſia*. 11. *Tartaria*. 12. *China*. 13. *India*. and 14. the Oriental Iſlands.

Anatolia *or* Aſia minor.

Anatolia or *Aſia minor*, is bounded on the Eaſt with the River *Euphrates*, by which it is parted from the greater *Aſia*; on the Weſt with the Thracian *Boſphorus*, *Propontis*, *Helleſpont*, and the

the Ægean Sea, by which it is parted from *Europe*; on the North with *Pontus Euxinus*, called also the black Sea, and *Mare Maggiore*, and on the South by the Rhodian, Lydian and Pamphilian Seas, several parts of the Mediterranean. So that it is a Demi-Island or *Peninsula* environed on all sides with water, excepting a small *Isthmus* or Neck of Land extending from the head of *Euphrates* to the Euxine Sea, by which it is joyned to the rest of *Asia*.

It reacheth from the 51 to the 72 degree of Longitude, and from the 36 to the 45 degree of Latitude, and lyeth almost in the same position with *Italy*, extending from the middle Parallel of the fourth Clime, to the middle Parallel of the sixth, so that the longest summers day in the Southern Parts, is about 14 hours and a half; and one hour longer in those parts which lie most towards the North.

The Provinces into which it was divided before the Roman Conquest were 1. *Bithynia*. 2. *Pontus*. 3. *Paphlagonia*. 4. *Galatia*. 5. *Cappadocia*. 6. *Armenia Major & Minor*. 7. *Phrygia minor*. 8. *Phrygia major*. 9. *Mysia* the greater and the less. 10. *Asia* specially so called, comprehending *Æolis* and *Ionia*. 11. *Lydia*. 12. *Caria*. 13. *Lycia*. 14. *Lycaonia*. 15. *Pisidia*. 16. *Pamphylia*. 17. *Isauria*. 18. *Cilicia*. 19. The Province of the Asian Isles, whereof the most principal are 1. *Tenedos*. 2. *Chios*. 3. *Samos*. 4. *Choos*. 5. *Icaria*. 6. *Lesbos*. 7. *Patmos*. 8. *Claros*. 9 *Carpathos*. 10. *Rhodes*.

Cyprus.

Cyprus is situated in the Syrian and Cilician Seas, extended in length from East to West 200 miles, in breadth 60 the whole compass reckoned 550, distant about 60 miles from the rocky Shores of *Cilicia* in *Asia minor*, and about one hundred from the main Land of *Syria*.

It is situated under the fourth Climate, so that the longest day in Summer is no more than 14 hours and a half.

Divided by *Ptolemy* into the 4 provinces of 1. *Paphia*. 2. *Amathasia*. 3. *Lepathia*. 4. *Salamine*.

Syria.

Syria is bounded on the East with the River *Euphrates* by which it is parted from *Mesopotamia*; on the West with the Mediterranean Sea; on the North with *Cilicia* and *Armenia minor*, parted from the last by mount *Taurus*; and on the South with *Palestine*, and some parts of *Arabia*. The length hereof from Mount *Taurus* to the Edge of *Arabia*, is said to be 525 Miles; the breadth from the Mediterranean to the River *Euphrates* 470 Miles, drawing somewhat near unto a Square.

The whole Country was antiently divided into these six parts. 1. *Phœnicia*. 2. *Palestine*. 3. *Syria* specially so called. 4. *Comagena*. 5. *Palmyrene*. and *Cælosyria*, or *Syria Cava*.

Arabia

Arabia.

Arabia hath on the East *Chaldæa* and the Bay or Gulf of *Persia*; on the West *Palestine*, some part of *Egypt*, and the whole course of the red Sea, on the North the River *Euphrates* with some parts of *Syria* and *Palestine*, and on the South the main southern Ocean. It is in circuit about 4000 Miles, but of so unequal and heteregeneous Composition, that no general Character can be given of it, and therefore we must look upon it as it stands divided into *Arabia Deserta*, 2. *Arabia Petræa*. 3. *Arabia Felix* and 4. The *Arabick* Islands.

Chaldea.

Chaldea is bounded on the East with *Susiana* a Province of *Persia*; on the West with *Arabia deserta*; on the North with *Mesopotamia*; and on the South with the Persian Bay and the rest of *Deserta*.

Assyria.

Assyria is bounded on the East with *Media*, from which it is parted by the Mountain called *Coathras*; on the West with *Mesopotamia*, from which it is divided by the River *Tygris*; on the South with *Susiana*; and on the North with some part of *Turcomania*; it was antiently divided into six parts. 1. *Arraphachitis*. 2. *Adiabene*. 3. *Calacine*. 4. *Aobelites*. 5. *Apolloniates*.

Mesopotamia

Meſopotamia.

Meſopotamia is bounded on the Eaſt with the River *Tygris* by which it is parted from *Aſſyria*; on the Weſt with *Euphrates* which divides it from *Comagena* a Province of *Syria*; on the North with Mount *Taurus*; by which it is ſeparated from *Armenia major*; and on the South with *Chaldea* and *Arabia deſerta* from which laſt it is parted by the bendings of *Euphrates* alſo. It was antiently divided into, 1. *Anthemaſia.* 2. *Chalcitis.* 3. *Caulanitis.* 4. *Acchabene.* 5. *Ancorabitis* and 6. *Ingine.*

Turcomania.

Turcomania is bounded on the Eaſt with *Media* and the Caſpian *Sea*; on the Weſt with the *Euxine* Sea, *Cappadocia* and *Armenia minor*; on the North with *Tartary*, and on the South with *Meſopotamia* and *Aſſyria*. A Countrey which conſiſteth of four Provinces. 1. *Armenia major* or *Turcomania* properly and ſpecially ſo called. 2. *Colchis.* 3. *Iberia.* 4. *Albania.*

Media.

Media is bounded on the Eaſt with *Parthia*, and ſome part of *Otyrcania*, Provinces of the Perſian Empire; on the Weſt with *Armenia major*, and ſome part of *Aſſyria*; on the North with the Caſpian Sea and thoſe parts of *Armenia major*, which now paſs in the account of *Iberia*, *Georgia*; and on the South with *Perſia*. It is now divided

divided into two Provinces. 1. *Atropatia.* 2. *Media major.*

Persia.

Persia is bounded on the East with *India*; on the West with *Media*, *Assyria*, and *Chaldea*; on the North with *Tartary*, on the South with the main Ocean.

It is divided into the particular Provinces of 1. *Susiana.* 2. *Persis.* 3. *Ormur.* 4. *Carmania.* 5. *Gedrosia.* 6. *Drangiana.* 7. *Arachosia.* 8. *Paropamisus.* 9. *Aria.* 10. *Parthia.* 11. *Hyrcania.* 12. *Margiana* and 13. *Bactria.*

Tartaria.

Tartaria is bounded on the East with *China*, the Oriental Ocean, and the Straits of *Anian*, by which it is parted from *America*, on the West with *Russia* and *Podolia*, a Province of the Realm of *Poland*; on the North with the main Scythick or frozen Ocean; and on the South with part of *China*, from which it is separated by a mighty Wall, some part of *India*, the River *Oxus* parting it from *Bactria* and *Margiana*, two Persian Provinces; the *Caspian* Sea which separates it from *Media* and *Hyrcania*; the *Caucasian* Mountains interposing between it and *Turcomania*; and the Euxine Sea which divideth it from *Anatolia* and *Thrace*.

It reacheth from the 50 degree of Longitude to the 195 which is 145 degrees from West to East; and from the 40 degree of Northern Latitude, unto the 80, which is within 10 degrees

grees of the Pole it ſelf, By which accompt it lieth from the beginning of the ſixth Clime, where the longeſt day in Summer is 15 hours, till they ceaſe meaſuring the Climates, the longeſt day in the moſt Northen parts hereof being full ſix Months, and in the winter half of the Year, the night as long.

It is now divided into theſe five parts. 1. *Tartaria Precopenſis.* 2. *Aſiatica.* 3. *Antiqua.* 4. *Zagathay.* 5. *Cathay.*

China.

China is bounded on the North with *Altay* and the Eaſtern *Tartars*, from which it is ſeparated by a continued Chain of Hills, part of thoſe of *Ararat*, and where that chain is broken off or interrupted, with a great wall extended 400 Leagues in length; on the South partly with *Cauchin China* a Province of *India*, partly with the Ocean; on the Eaſt with the oriental Ocean, and on the Weſt with part of *India* and *Cathay*.

It reacheth from the 130 to the 160 degree of Longitude, and from the Tropick of *Cancer* to the 53 degree of Latitude; ſo that it lieth under all the Climes from the third to the ninth incluſively. The longeſt ſummers day in the ſouthern parts being 13 hours and 40 Minutes increaſed in the moſt northern parts to 16 hours and 3 quarters.

It containeth no fewer than 15 Provinces. 1. *Canton.* 2. *Foquien.* 3. *Olam.* 4. *Siſnam* 5. *Tolenchia.* 6. *Cauſay.* 7. *Minchian.* 8. *Ochian.* 9. *Honan.* 10. *Pagnia.* 11. *Taitan.* 12. *Quinchen.* 13. *Chagnian* 14. *Suſnan.* 15. *Cuniſay.*

nisay. Besides the provinces of *Suehuen*, the Island of *Chorea* and the Island of *Cheaxan*.

India.

India is bounded on the East with the Oriental Ocean and some part of *China*; on the West with the Persian Empire; on the North with some Branches of Mount *Taurus*, which divide it from *Tartary*; on the South with the Indian Ocean.

Extended from 106 to 159 degrees of Longitude, and from the *Æquator* to the 44th degree of Northern Latitude, by which account it lieth from the beginning of the first to the end of the sixth Clime, the longest Summers day in the southern Parts being 12 hours onely, and in the parts most North 15 hours and a half.

The whole Country is divided into two main parts, *India intra Gangem*, and *India extra Gangem*.

The Oriental Islands.

The Oriental Islands are 1. *Japan*. 2. The *Philippine* and Isles adjoyning. 3. The Islands of *Bantam*. 4. The *Moluccoes*. 5. Those called *Sinda* or the *Celebes*. 6. *Java*. 7. *Borneo*. 8. *Sumatra*. 9. *Ceilan*. and 10. others of less note.

Chap. V.

CHAP. V.

Of Africk.

AFrick is bounded on the East by the Red Sea, and Bay of *Arabia*, by which it is parted from *Asia*; on the West by the main Atlantick Oceans interposing between it and *America*; on the North by the Mediterranean Sea, which divides it from *Europe* and *Anatolia*; and on the South with the Æthiopick Ocean, separating it from *Terra Australis incognita* or the southern continent, parted from all the rest of the World except *Asia* only, to which it is joyned by a narrow *Isthmus* not above 60 miles in length.

It is situate for the most part under the Torrid Zones, the *Æquator* crossing it almost in the midst. It is now commonly divided into these seven parts. 1. *Ægypt*. 2. *Barbary* or the Roman Africk. 3. *Numidia*. 4. *Lybia*. 5. *Terra Nigritarum*. 6. *Æthiopia superior*. and 7. *Æthiopia inferior*.

Ægypt.

Ægypt is bounded on the East with *Idumea*, and the Bay of *Arabia*; on the West with *Barbary*, *Numidia*, and part of *Lybia*; on the North with the Mediterranean Sea; on the South with *Æthiopia superior*, or the *Abyssyn* Emperor; it is situate under the second and fifth Climates, so that the longest day in Summer is but thirteen hours and a half.

Barbary.

Barbary is bounded on the East with *Cyrenaica*; on the West with the Atlantick Ocean; on the North with the Mediterranean Sea, the Straits of *Gibralter* and some part of the Atlantick also; on the South with Mount *Atlas*, by which it is separated from *Lybia inferior* or the Desarts of *Lybia*.

It is situated under the third and fourth Climates: so that the longest Summers day in the parts most South, amounteth to 13 hours and 3 quarters, and in the most northern parts it is 14 hours and a quarter. This country is now reduced to the Kingdoms of 1. *Tunis*. 2. *Tremesch* or *Algiers*. 3. *Fesse* and 4. *Morocco*.

Numidia.

Numidia is bounded on the East with *Egypt*, on the West with the Atlantick Ocean; on the North with Mount *Atlas*, which parteth it from *Barbary* and *Cyrene*; on the South with *Lybia Deserta*.

Lybia.

Lybia is either *Interior* or *Deserta*, *Libia interior* is bounded on the North with Mount *Atlas* by which it is parted from *Barbary* and *Cyrenaica*; on the East with *Lybia Marmarica* interposed between it and *Egypt*, and part of *Æthiopia superior*, or the Habassine Empire; on the South with *Æthiopia inferior*, and the Land of the Negroes

groes; and on the West with the main Atlantick Ocean.

Lybia deserta is bounded on the North with *Numidia* or *Biledulgerid*; on the South with the Land of the Negroes; and on the West with *Gulata* another Province of the Negroes interposed between it and the Atlantick.

Terra Nigritarum.

Terra Nigritarum or the Land of the Negroes is bounded on the East with *Æthiopia Superior*; on the West with the Atlantick Ocean; on the North with *Lybia deserta* and on the South with the Ethiopick Ocean, and part of *Æthiopia Inferior*.

Æthiopia Superior.

Æthiopia Superior is bounded on the East with the Red Sea and the *Sinus Barbaricus*; on the West with *Lybia Interior*, the Realm of *Nubia* in the Land of the Negroes and part of the Kingdoms of *Congo* in the other *Æthiopia*; on the North with *Egypt* and *Lybia Marmarica*, and on the South with the Mountains of the Moon, by which it is parted from the main Body of *Æthiopia Inferior*.

It is situate on both sides of the Æquinoctial, extending from the South Parallel of seven degrees, where it meeteth with some part of the other *Æthiopia* to the Northern end of the Isle of *Meroe* situated under the fifth Parallel on the North of that Circle.

Æthiopia Inferior.

Æthiopia inferior is bounded on the East with the Red Sea; on the West with the Ethiopick Ocean; on the North with *Terra Nigritarum*, and the higher *Æthiopia*; and on the South where it endeth, is a point of a *Conus*, with the main Ocean parting it from the Southern undiscovered Continent. This in *Ptolemyes* time went under the name of *Terra incognita*.

CHAP. XVI

Of America.

A*Merica* the fourth and last part of the World is bounded on the East with the Atlantick Ocean and the *Vergivian* Seas, by which it is parted from *Europe* and *Africa*; on the West with the *Pacifick* Ocean, which divides it from *Asia*; on the South with some part of *Terra Australis incognita*, from which it is separated by a long, but narrow Strait, called the Straits of *Magellan*; the North bounds of it hitherto not so well discovered, as that we can certainly affirm it to be Island or Continent.

It is called by some and that most aptly, The new World; New for the late discovery, and World for the vast greatness of it. The whole is naturally divided into two great Peninsules, whereof that towards the North is called *Mexicana*. That towards the South hath the name of *Peruana*: the *Isthmus* which joyneth these two together

together is very long, but narrow in ſome places not above 120 miles from Sea to Sea, in many not above ſeventeen.

The Northern *Peninſula* called *Mexicana*, may be moſt properly divided into the Continent and Iſlands: The Continent again into the ſeveral Provinces of 1. *Eſtotiland*, 2. *Nova Francia*, 3. *Virginia*, 4. *Florida*, 5. *California*, 6. *Nova Gallicia*, 7. *Nova Hiſpania*, 8. *Guntimala*. The Southern *Peninſula* called *Peruana*, taking in ſome part of the *Iſthmus*, hath on the Continent the Provinces of 1. *Caſtella Aurea*, 2. *Nova Granada*, 3. *Peru*, 4. *Chile*, 5. *Paraguay*, 6. *Braſil*, 7. *Guiana*, and 8. *Paria*. The Iſlands which belong to both, are diſperſed either in the Southern Ocean called *Mare del Zur*, where there is not any one of Note but thoſe called *Los Ladrones* and the Iſlands of *Solomon*. Or in the Northern Ocean called *Mare del Noords*, reduced unto the *Caribes*, *Porto-Rico*, *Hiſpaniola*, *Cuba* and *Jamaica*. And thus much concerning the real and known parts of the Terreſtrial Globe.

CHAP. VII.

Of the Deſcription of the Terreſtrial Globe by Maps Univerſal and Particular.

Hitherto we have ſpoken of the true and real Terreſtrial Globe, and of the meaſure thereof by Circles, Zones, and Climates, as it is uſually repreſented by a Sphere or Globe; which muſt be confeſſed to be the neareſt and the moſt commenſurable to nature: Yet it may alſo be

deſcribed upon a plain, in whole or in part many ſeveral ways: But thoſe which are moſt uſeful and artificial are theſe two, by Parallelogram and by Planiſphere.

2. The deſcription thereof by Parallelogram is thus, the Parallelogram is divided in the midſt by a line drawn from North to South, paſſing by the *Azores* or *Canaries* for the great Meridian. Croſs to this and at eight Angles, another line is drawn from Eaſt to Weſt for the *Æquator*; then two parallels to each to comprehend the figure, in the ſquares whereof there are ſet down four parts of the world rather than the whole: And this way of deſcription though not exact or near to the natural, hath yet been followed by ſuch as ought ſtill to be accounted excellent, and is the form of our plain Charts, and in places near the Æquinoctial may be uſed without committing any great error; beeauſe the Meridians about the Æquinoctial are equi-diſtant, but as they draw up towards the Pole, they do upon the Globe come nearer and nearer together, to ſhew that their diſtance is proportionably diminiſhed till it come to a concurrence, and anſwerably the Parallels as they are deeper in latitude, ſo they grow leſs and leſs with the Sphere; ſo that at 60 degrees, the Equinoctial is double to the parallel of Latitude, and ſo proportionably of the reſt.

3. Hence it followeth, that if the picture of the earth be drawn upon a Parallelogram, ſo that the Meridians be equally diſtant throughout, and the Parallels equally extended, the Parellel of 60 degrees ſhall be as great as the line of the *Æquator* it ſelf is, and he that coaſteth about the world

in the latitude of 60 degrees, ſhall have as far to go by this Map, as he that doth it in the *Æquator*, though the way be but half as long. For the longitude of the Earth in the *Æquator* it ſelf, is 21600; but in the Parallel of 60 but 10800 miles. So two Cities under the ſame parallel of 60, ſhall be of equal Longitude to other two under the Line, and yet the firſt two ſhall be but 50, the other two an hundred miles diſtant. So two Ships departing from the *Æquator* at 60 miles diſtance, and coming up to the Parallel of 60, ſhall be thirty miles nearer, and yet each of them keep the ſame Meridians and ſail by this Card upon the very points of the Compaſs at which they ſet forth. This was complained of by *Martin Cortez* and others, and the learned *Mercator* conſidering well of it, cauſed the degrees of the Parallel to increaſe by a proportion towards the Pole. The Mathematical Generation whereof, Mr. *Wright* in the ſecond Chapter of his *Correction of Errors in Navigation*, hath ſought by the inſcription of a Planiſphere into a Concave Cylinder. And this deſcription of the Earth upon a Parallelogram, may indeed be ſo ordered by Art, as to give a true account of the ſcituation and diſtance of the parts, but cannot be fitted to repreſent the figure of the whole.

4. The deſcription therefore of the whole by Planiſphere is much better, becauſe it repreſents the face of the Earth upon a plain, in its own proper Spherical Figure as upon the Globe it ſelf. This deſcription cannot well be contrived upon ſo few as one Circle or more than two.

Suppoſe then the Globe to be divided into

two

two equal parts or Hemiſpheres, which cannot be done but by a great Circle : And therefore it muſt be done by the *Æquator* or Meridian (for the Colure is all one with the Meridian) the Horizon cannot fix, and the Zodiack hath nothing to do here.

5. Suppoſe then the Globe to be flatted upon the plain of the *Æquator*, and you have the firſt way of projection dividing the Globe into the North and South Hemiſpheres.

In this projection the Pole is the Centre, the *Æquator* is the Circumference divided into 360 degrees of Longitude, the Parallels are whole Circles, the Meridians are ſtreight lines, the Parallels are Parallels indeed, and the Meridians equi-diſtantly concur, and therefore all the degrees are equal. After this way of projection, *Ptolemy* deſcribes that part of the habitable world which was diſcovered to his time.

6. Suppoſe the Globe to be flatted upon the plain of the Meridian, and you have the other way of projection;the *Æquator* here is a ſtreight line, the great Meridian a whole Circle, in this Section the Meridians do not equi-diſtantly concur, the Parallels are not Parallels indeed, and therefore the degrees are all unequal.

However, this latter way is that which is now moſt and indeed altogether in uſe.

7. Particular Maps are but limbs of the Globe, and therefore though they are drawn aſunder, yet are they ſtill to be done with that proportion, as a remembring eye may ſuddenly acknowledge, and joyn them to the whole Body.

The

The Projection is most commonly upon a Parallelogram, in which the Latitude is to be expressed by Parallels from North to South, and the Longitude by Meridians from West to East at 10 or 15 degrees distance, as you please, and may be drawn either by circle or right Lines; but if they be right Lines, the Meridians are not to be drawn parallel, but inclining and concurring, to shew the nature of the whole, whereof they are such parts. For the Graduation; the degrees of Longitude are most commonly divided upon the North and South sides of the Parallelogram; the degrees of Latitude upon the East and West sides, or otherwise upon the most Eastern or Western Meridian of the Map, within the square. But it hath seemed good to some in these particular descriptions to make no graduation or projection at all; but to put the matter off to a scale of Miles, and leave the rest to be believed.

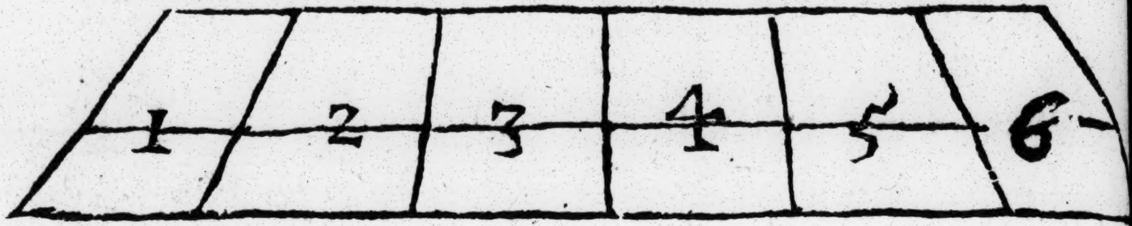
The difference of Miles in several Countries is great, but it will be enough to know that the Italian and English, are reckoned for all one, and four of these do make a German Mile; two a French League. The Swedish or Danish Mile consisteth of 5 Miles English and somewhat more. Sixty common English and Italian Miles answer to a degree of a great Circle.

Now as the Miles of several Countries do very much differ, so those of the same do not very much agree: and therefore the scales are commonly written upon with *Magna*, *Mediocria* and *Parva*, to shew the difference. In some Maps you shall find the Miles thus hiddenly set down, and the meaning is, that you should measure the

Milliaria

Milliaria magna upon the lowermost Line, the *Parva* upon the uppermost, and the *Mediocria* upon the middlemost.

Scala Milliarium.



The use of the Scale is for the measuring the distances of places in the Map, by setting one foot of your Compasses in the little circle representing one place, and the other foot in the like little circle representing another, the Compasses kept at that distance being applied to the Scale, will shew the number of great or middle Miles according as the inhabitants of those places are known to reckon.

James Burges

Soli Deo Gloria.

A View

A View of the more Notable *Epochæ*

Epochæ.	Years of the Julian Period.	Months
The Julian Period	1	*Jan.* 1
Creation of the World	765	*Jan.* 1
Æra of the *Olympiades*	3938	*July* 8
The building of *Rome*	4961	*Ap.* 21
Epochæ of *Nabonaſſer*	3667	*Feb.* 26
The beginning of *Metons* Cyrcle.	4281	*June* 26
The beginning of the periods of *Calippus*	4384	*June* 28
The Death of *Alexander* the great	4390	*No.* 12
Æra of the *Caldees*	4403	*Oct.* 15
The *Æra* of *Dionyſius*	4429	*Mar.* 25

The beginning of the Chriſtian *Æra* falls in the 4713 year of the Julian Period.	Years of Chriſt	Month
The Diocleſian *Æra*	284	*Aug.* 29
The Turkiſh *Æra* or *Hegyra*	622	*July* 16
The Perſian *Æra* from *Ieſdagird*	632	*June* 16
The *Æra* from the Perſian *Sultan*	1079	*Mar.* 14

Days in the Year of

Julian Accompt								*Ægypt* and Perſian Accompt							
1	0	0	0	365	2	5	0	1	0	0	0	365	0	0	0
2	0	0	0	730	5	0	0	2	0	0	0	730	0	0	0
3	0	0	0	1095	7	5	0	3	0	0	0	1095	0	0	0
4	0	0	0	1461	0	0	0	4	0	0	0	1460	0	0	0
5	0	0	0	1826	2	5	0	5	0	0	0	1825	0	0	0
6	0	0	0	2191	5	0	0	6	0	0	0	2190	0	0	0
7	0	0	0	2556	7	5	0	7	0	0	0	2555	0	0	0
8	0	0	0	2922	0	0	0	8	0	0	0	2920	0	0	0
9	0	0	0	3287	2	5	0	9	0	0	0	3285	0	0	0
10	0	0	0	3652	5	0	0	10	0	0	0	3650	0	0	0

Days in Julian Months		Days in Ægyptian Months		Days in Persian Months	
Comon	Bissex				
January 31	30	*Thoth*	30	*Pharvadin*	30
February 59	60	*Paophi*	60	*Aripehast*	60
March 90	91	*Athyr*	90	*Chortat*	90
April 120	121	*(Chæae)* Choiac	120	*Tirma*	120
May 151	152	*Mechir*	180	*Sachriur*	180
June 181	182	*Phamenoth*	210	*Macherma*	210
July 212	213	*Pharmuthi*	240	*Apenina Wahak*	245
August 243	244	*Pachon*	270		
September 273	274	*(Payny)* Pauni	300	*Aderma*	275
October 304	305	*Ephephi* (Epiphi	330	*Dima*	305
November 334	335	*Mesori*	330	*Pechmam*	335
December 365	366	*Epagomena*	365	*Aphander*	365

Days in Turkish or Arabical Years						Days in Turkish Months	
1	354	21		7442		*Muharram*	30
2	709	22		7796		*Saphar*	59
3	·1063	23		8150		*Rabi* 1.	89
4	·1417	24		8505		*Rabi* 2	118
5	·1772	25		8859		*Giumadi* 1.	148
6	·2126	26		9213		*Giumadi* 2.	177
7	·2480	27		9568		*Regeb* (Rajab	207
8	·2835	28		9922		*Sahaban*	236
9	·3189	29		10276		*Ramadhan*	266
10	·3543	30	0	10631	0	*Scheval*	295
11	·3898	60	0	21262	0	*Dulkadati*	325
12	·4252	90	0	31893	0	*Dulhajati Dsilhittsche true*	354
13	·4607	120	0	42524	0		
14	·4961	150	0	53155	0		
15	·5315	180	0	63786	0	*In anno Abundanti*	355
16	·5670	210	0	74417	0		
17	·6024	240	0	05048	0		
18	·6378	270	0	95679	0		
19	·6733	300	0	106310	0		
20	·7087						

	January			February			March		
1	3	A	Circumcis.		D	Purificat	3	D	
2		B		11	E			E	
3	11	C		19	F		11	F	
4		D		8	G			G	
5	19	E			A		19	A	
6	8	F	Epiphany	16	B		8	B	
7		G		5	C			C	
8	16	A			D		16	D	
9	5	B		13	E		5	E	
10		C		2	F			F	
11	13	D			G		13	G	
12	2	E		10	A		2	A	
13		F			B			B	
14	10	G		18	C		10	C	
15		A		7	D			D	
16	18	B			E		18	E	
17	7	C		15	F		7	F	
18		D		4	G			G	
19	15	E			A		15	A	
20	4	F		12	B		4	B	
21		G		1	C			C	
22	12	A			D		12	D	
23	1	B		9	E		1	E	
24		C			F			F	
25	9	D	Conv.S.Paul	17	G	S.Matthias	9	G	Anunc.
26		E		6	A			A	
27	17	F			B		17	B	
28	6	G		14	C		6	C	
29		A						D	
30	14	B					14	E	
31	3	C					3	F	

	April			May			June		
1		G		11	B	Phil.& Jac.		E	
2	11	A			C		19	F	
3		B		19	D		8	G	
4	19	C		8	E		16	A	
5	8	D			F		5	B	
6	16	E		16	G			C	
7	5	F		5	A		13	D	
8		G			B		2	E	
9	13	A		14	C			F	
10	2	B		2	D		10	G	
11		C			E			A	S.Barnaby
12	10	D		10	F		18	B	
13		E			G		7	C	
14	18	F		18	A			D	
15	7	G		7	B		15	E	
16		A			C		4	F	
17	15	B		15	D			G	
18	4	C		4	E		12	A	
19		D			F		1	B	
20	12	E		12	G			C	
21	1	F		1	A		9	D	
22		G			B			E	
23	9	A		9	C		17	F	
24		B			D		6	G	S.John B.
25	17	C	Mark Evang.	17	E			A	
26	6	D		6	F		14	B	
27		E			G		3	C	
28	14	F		14	A			D	
29	5	G		3	B		11	E	Pet.Ap.
30		A			C			F	
31				11	D				

	July			August			September		
1	15	G		8	C		16	F	
2	8	A		16	D		5	G	
3		B		5	E			A	
4	16	C			F		13	B	
5	5	D		13	G		2	C	
6		E		2	A			D	
7	13	F			B		10	E	
8	2	G		10	C			F	
9		A			D		18	G	
10	10	B		18	E		7	A	
11		C		7	F			B	
12	18	D			G		15	C	
13	7	E		15	A		4	D	
14		F		4	B			E	
15	15	G			C		12	F	
16	4	A		12	D		1	G	
17		B		1	E			A	
18	12	C			F		9	B	
19	1	D		9	G			C	
20		E	Margaret		A		17	D	
21	9	F		17	B		6	E	S. Matth.
22		G		6	C			F	
23	17	A			D		14	G	
24	6	B		14	E	Barthol.	3	A	
25		C		3	F			B	
26	14	D		11	G		11	C	
27	3	E		19	A		19	D	
28		F			B		8	E	
29	11	G		8	C			F	S.Mich.
30	9	A			D			G	
31		B			E				

	October				November			December		
1	16	A			D	All Saints	13	F	
2	5	B		13	E	All Souls	2	G	
3	13	C		2	F			A	
4	2	D			G		10	B	
5		E		10	A	P. Conspir.		C	
6	10	F			B		18	D	
7		G		18	C		7	E	
8	18	A		7	D			F	
9	7	B			E		15	G	
10		C		15	F		4	A	
11	15	D		4	G			B	
12	4	E			A		12	C	
13		F		12	B		1	D	
14	12	G		1	C			E	
15	13	A			D		9	F	
16		B		9	E			G	
17	9	C			F		17	A	
18		D	Luke Evang.	17	G		6	B	
19	17	E		6	A			C	
20	6	F			B		14	D	
21		G		14	C		3	E	S. Thomas
22	14	A		3	D			F	
23	3	B			E		11	G	
24		C		11	F		19	A	
25	11	D		19	G			B	Chris. Nat.
26	19	E			A		8	C	S. Steph.
27		F		8	B			D	S. John
28	8	G	Sim. & Jude		C		16	E	Innocents
29		A		16	D		5	F	
30	16	B		5	E	S. Andrew		G	
31	5	C					13	A	Sylvester

	January		February		March	
1	*	A	XXIX	D	*	D
2	XXIX	B	XXVIII	E	XXIX	E
3	XXVIII	C	XXVII	F	XXVIII	F
4	XXVII	D	25.XXVI	G	XXVII	G
5	XXVI	E	XXV.XXIV	A	XXVI	A
6	25.XXV	F	XXIII	B	25.XXV	B
7	XXIV	G	XXII	C	XXIV	C
8	XXIII	A	XXI	D	XXIII	D
9	XXII	B	XX	E	XXII	E
10	XXI	C	XIX	F	XXI	F
11	XX	D	XVIII	G	XX	G
12	XIX	E	XVII	A	XIX	A
13	XVIII	F	XVI	B	XVIII	B
14	XVII	G	XV	C	XVII	C
15	XVI	A	XIV	D	XVI	D
16	XV	B	XIII	E	XV	E
17	XIV	C	XII	F	XIV	F
18	XIII	D	XI	G	XIII	G
19	XII	E	X	A	XII	A
20	XI	F	IX	B	XI	B
21	X	G	VIII	C	X	C
22	IX	A	VII	D	IX	D
23	VIII	B	VI	E	VIII	E
24	VII	C	V	F	VII	F
25	VI	D	IV	G	VI	G
26	V	E	III	A	V	A
27	IV	F	II	B	IV	B
28	III	G	I	C	III	C
29	II	A			II	D
30	I	B			I	E
31	*	C			*	F

	April		May		June	
1	XXIX	G	XXVIII	B	XXVII	E
2	XXVIII	A	XXVII	C	25.XXVI	F
3	XXVII	B	XXVI	D	XXV.XXIV	G
4	25.XXVI	C	25.XXV	E	XXIII	A
5	XXV.XXIV	D	XXIV	F	XXII	B
6	XXIII	E	XXIII	G	XXI	C
7	XXII	F	XXII	A	XX	D
8	XXI	G	XXI	B	XIX	E
9	XX	A	XX	C	XVIII	F
10	XIX	B	XIX	D	XVII	G
11	XVIII	C	XVIII	E	XVI	A
12	XVII	D	XVII	F	XV	B
13	XVI	E	XVI	G	XIV	C
14	XV	F	XV	A	XIII	D
15	XIV	G	XIV	B	XII	E
16	XIII	A	XIII	C	XI	F
17	XII	B	XII	D	X	G
18	XI	C	XI	E	IX	A
19	X	D	X	F	VIII	B
20	IX	E	IX	G	VII	C
21	VIII	F	VIII	A	VI	D
22	VII	G	VII	B	V	E
23	VI	A	VI	C	IV	F
24	V	B	V	D	III	G
25	IV	C	IV	E	II	A
26	III	D	III	F	I	B
27	II	E	II	G	*	C
28	I	F	I	A	XXIX	D
29	*	G	*	B	XXVIII	E
30	XXIX	A	XXIX	C	XXVII	F
31			XXVIII	D		

	July		August		September	
1	XXVI	G	XXV. XXIV	C	XXIII	F
2	25.XXV	A	XXIII	D	XXII	G
3	XXIV	B	XXII	E	XXI	A
4	XXIII	C	XXI	F	XX	B
5	XXII	D	XX	G	XIX	C
6	XXI	E	XIX	A	XVIII	D
7	XX	F	XVIII	B	XVII	E
8	XIX	G	XVII	C	XVI	F
9	XVIII	A	XVI	D	XV	G
10	XVII	B	XV	E	XIV	A
11	XVI	C	XIV	F	XIII	B
12	XV	D	XIII	G	XII	C
13	XIV	E	XII	A	XI	D
14	XIII	F	XI	B	X	E
15	XII	G	X	C	IX	F
16	XI	A	IX	D	VIII	G
17	X	B	VIII	E	VII	A
18	IX	C	VII	F	VI	B
19	VIII	D	VI	G	V	C
20	VII	E	V	A	IV	D
21	VI	F	IV	B	III	E
22	V	G	III	C	II	F
23	IV	A	II	D	I	G
24	III	B	I	E	*	A
25	II	C	*	F	XXIX	B
26	I	D	XXIX	G	XXVIII	C
27	*	E	XXVIII	A	XXVII	D
28	XXIX	F	XXVII	B	25.XXVI	E
29	XXVIII	G	XXVI	C	XXV. XXIV	F
30	XXVII	A	25.XXV	D	XXIII	G
31	25.XXVI	B	XXIV	E		

	October		November		December	
1	XXII	A	XXI	D	XX	F
2	XXI	B	XX	E	XIX	G
3	XX	C	XIX	F	XVIII	A
4	XIX	D	XVIII	G	XVII	B
5	XVIII	E	XVII	A	XVI	C
6	XVII	F	XVI	B	XV	D
7	XVI	G	XV	C	XIV	E
8	XV	A	XIV	D	XIII	F
9	XIV	B	XIII	E	XII	G
10	XIII	C	XII	F	XI	A
11	XII	D	XI	G	X	B
12	XI	E	X	A	IX	C
13	X	F	IX	B	VIII	D
14	IX	G	VIII	C	VII	E
15	VIII	A	VII	D	VI	F
16	VII	B	VI	E	V	G
17	VI	C	V	F	IV	A
18	V	D	IV	G	III	B
19	IV	E	III	A	II	C
20	III	F	II	B	I	D
21	II	G	I	C	*	E
22	I	A	*	D	XXIX	F
23	*	B	XXIX	E	XXVIII	G
24	XXIX	C	XXVIII	F	XXVII	A
25	XXVIII	D	XXVII	G	XXVI	B
26	XXVII	E	25.XXVI	A	25.XXV	C
27	XXVI	F	XXV. XXIV	B	XXIV	D
28	25.XXV	G	XXIII	C	XXIII	E
29	XXIV	A	XXII	D	XXII	F
30	XXIII	B	XXI	E	XXI	G
31	XXII	C			XX	A

A Table shewing the Dominical Letter, Golden Number and Epact, according to the Julian account for ever, and in the Gregorian, till the Year 1700.

1672	1	GF	CB
1673	2	E	A
1674	3	D	G
1675	4	C	F
1676	5	BA	ED
1677	6	G	C
1678	7	F	B
1679	8	E	A
1680	9	DC	GF
1681	10	B	E
1682	11	A	D
1683	12	G	C
1684	13	FE	BA
1685	14	D	G
1686	15	C	F
1687	16	B	E
1688	17	AG	DC
1689	18	F	B
1690	19	E	A
1691	20	D	G
1692	21	CB	FE
1693	22	A	D
1694	23	G	C
1695	24	F	B
1696	25	ED	AG
1697	26	C	F
1698	27	B	E
1699	28	A	D

Year	G N	Julian Epact	Gregor. Epact
1672	1	11	1
1673	2	22	12
1674	3	3	23
1675	4	14	4
1676	5	25	15
1677	6	6	26
1678	7	17	7
1679	8	28	18
1680	9	9	29
1681	10	20	10
1682	11	1	21
1683	12	12	2
1684	13	23	13
1685	14	4	24
1686	15	15	5
1687	16	26	16
1688	17	7	17
1689	18	18	8
1690	19	29	19

The anticipation of the Gregorian Calendar.

From 5 *October*	1582	D. 10
From 24 *Feb.*	1700	D. 11
From 24 *Feb.*	1800	D. 12
From 24 *Feb.*	1900	D. 13
From 24 *Feb.*	2100	D. 14
From 24 *Feb.*	2200	D. 15
From 24 *Feb.*	2320	D. 16

		III	IV	V	VI	VII	VIII
1	P	*	XI	XXII	III	XIV	XXV
2	N	XXIX	X	XXI	II	XIII	XXIV
3	M	XXVIII	IX	XX	I	XII	XXIII
4	H	XXVII	VIII	XIX	*	XI	XXII
5	G	XXVI	VII	XVIII	XXIX	X	XXI
6	F	XXV	VI	XVII	XXVIII	IX	XX
7	E	XXIV	V	XVI	XXVII	VIII	XIX
8	D	XXIII	IV	XV	XXVI	VII	XVIII
9	C	XXII	III	XIV	XXV	VI	XVII
10	B	XXI	II	XIII	XXIV	V	XVI
11	A	XX	I	XII	XXIII	IV	XV
12	u	XIX	*	XI	XXII	III	XIV
13	t	XVIII	XXIX	X	XXI	II	XIII
14	ſ	XVII	XXVIII	IX	XX	I	XII
15	r	XVI	XXVII	VIII	XIX	*	XI
16	q	XV	XXVI	VII	XVIII	XXIX	X
17	p	XIV	XXV	VI	XVII	XXVIII	IX
18	n	XIII	XXIV	V	XVI	XXVII	VIII
19	m	XII	XXIII	IV	XV	XXVI	VII
20	l	XI	XXII	III	XIV	XXV	VI
21	k	X	XXI	II	XIII	XXIV	V
22	i	IX	XX	I	XII	XXIII	IV
23	h	VIII	XIX	*	XI	XXII	III
24	g	VII	XVIII	XXIX	X	XXI	II
25	f	VI	XVII	XXVIII	IX	XX	I
26	e	V	XVI	XXVII	VIII	XIX	*
27	d	IV	XV	XXVI	VII	XVIII	XXIX
28	c	III	XIV	XXV	VI	XVII	XXVIII
29	b	II	XIII	XXIV	V	XVI	XXVII
30	a	I	XII	XXIII	IV	XV	XXVI

IX	X	XI	XII	XIII	XIV	XV
VI	XVII	XXVIII	IX	XX	I	XII
V	XVI	XXVII	VIII	XIX	*	XI
IV	XV	XXVI	VII	XVIII	XXIX	X
III	XIV	XXV	VI	XVII	XXVIII	IX
II	XIII	XXIV	V	XVI	XXVII	VIII
I	XII	XXIII	IV	XV	XXVI	VII
*	XI	XXII	III	XIV	25	VI
XXIX	X	XXI	II	XIII	XXIV	V
XXVIII	IX	XX	I	XII	XXIII	IV
XXVII	VIII	XIX	*	XI	XXII	III
XXVI	VII	XVIII	XXIX	X	XXI	II
XXV	VI	XVII	XXVIII	IX	XX	I
XXIV	V	XVI	XXVII	VIII	XIX	*
XXIII	IV	XV	XXVI	VII	XVIII	XXIX
XXII	III	XIV	XXV	VI	XVII	XXVIII
XXI	II	XIII	XXIV	V	XVI	XXVI
XX	I	XII	XXIII	IV	XV	XXVII
XIX	*	XI	XXII	III	XIV	25
XVIII	XXIX	X	XXI	II	XIII	XXIV
XVII	XXVIII	IX	XX	I	XII	XXIII
XVI	XXVII	VIII	XIX	*	XI	XXII
XV	XXVI	VII	XVIII	XXIX	X	XXI
XIV	XV	VI	XVII	XXVIII	IX	XX
XIII	XXIV	V	XVI	XXVII	VIII	XIX
XII	XXIII	IV	XV	XXVI	VII	XVIII
XI	XXII	III	XIV	25	VI	XVII
X	XXI	II	XIII	XXIV	V	XVI
IX	XX	I	XII	XXIII	IV	XV
VIII	XIX	*	XI	XXII	III	XIV
VII	XVIII	XXIX	X	XXI	II	XIII

	XVI	XVII	XVIII	XIX	I	II
P	XXIII	IV	XV	XXVI	VIII	XIX
N	XXII	III	XIV	25	VII	XVIII
M	XXI	II	XIII	XXIV	VI	XVII
H	XX	I	XII	XXIII	V	XVI
G	XIX	*	XI	XXII	IV	XV
F	XVIII	XXIX	X	XXI	III	XIV
E	XVII	XXVIII	IX	XX	II	XIII
D	XVI	XXVII	VIII	XIX	I	XII
C	XV	XXVI	VII	XVIII	*	XI
B	XIV	25	VI	XVII	XXIX	X
A	XIII	XXIV	V	XVI	XXVIII	IX
u	XII	XXIII	IV	XV	XXVII	VIII
t	XI	XXII	III	XIV	XXVI	VII
t	X	XXI	II	XIII	25	VI
r	IX	XX	I	XII	XXIV	V
q	VIII	XIX	*	XI	XXIII	IV
p	VII	XVIII	XXIX	X	XXII	III
n	VI	XVII	XXVIII	IX	XXI	II
m	V	XVI	XXVII	VIII	XX	I
l	IV	XV	XXVI	VII	XIX	*
k	III	XIV	25	VI	XVIII	XXIX
i	II	XIII	XXIV	V	XVII	XXVIII
h	I	XII	XXIII	IV	XVI	XXVII
g	*	XI	XXII	III	XV	XXVI
f	XXIX	X	XXI	II	XIV	25
e	XXVIII	IX	XX	I	XIII	XXIV
d	XXVII	VIII	XIX	*	XII	XXIII
c	XXVI	VII	XVIII	XXIX	XI	XXII
b	25	VI	XVII	XXVIII	X	XXI
a	XXIV	V	XVI	XXVII	IX	XX

Anni Christi.

N	1		
P	320		
P	580	Biſſ.	
a	800	Biſſ.	C
b	1100	Biſſ.	C
c	1400	Biſſ.	C

Detractis decem diebus.

D	1484		
D	1600	Biſſ.	
C	1700		
C	1800		CC
B	1900		
B	2000	Biſſ.	
B	2100		C
A	2200		
u	2300		
A	2409	Biſſ.	C
u	2500		
t	2600		
t	2700		C
t	2800	Biſſ.	
ſ	2900		
ſ	3000		C
r	3100		
r	3200	Biſſ.	
r	3300		C
q	3400		
p	3500		

Anni Christi.

q	3600	Biſſ.	C
p	3700		
n	3800		
n	3900		
n	4000	Biſſ.	C
m	4100		
l	4200		
l	4300		CC
l	4400	Biſſ.	
k	4500		
k	4600		C
i	4700		
i	4800	Biſſ.	
i	4900		C
h	5000		
g	5100		
h	5200	Biſſ.	C
g	5300		
f	5400		
f	5500		C
f	5600	Biſſ.	
e	5700		
e	5800		C
d	5900		
d	6000	Biſſ.	
d	6100		C
c	6200		
b	6300		
c	6400	Biſſ.	C
b	6500		

A Table shewing the Dominical Letter both in the Julian and the Gregorian account for ever.

Cy. ☉	1	2	3	4	5	6	7
1	C B	D C	E D	F E	G F	A G	B A
2	A	B	C	D	E	F	G
3	G	A	B	C	D	E	F
4	F	G	A	B	C	D	E
5	E D	F E	G F	A G	B A	C B	D C
6	C	D	E	F	G	A	B
7	B	C	D	E	F	G	A
8	A	B	C	D	E	F	G
9	G F	A G	B A	C B	D C	E D	F E
10	E	F	G	A	B	C	D
11	D	E	F	G	A	B	C
12	C	D	E	F	G	A	B
13	B A	C B	D C	E D	F E	G F	A G
14	G	A	B	C	D	E	F
15	F	G	A	B	C	D	E
16	E	F	G	A	B	C	D
17	D C	E D	F E	G F	A G	B A	C B
18	B	C	D	E	F	G	A
19	A	B	C	D	E	F	G
20	G	A	B	C	D	E	F
21	F E	G F	A G	B A	C B	D C	E D
22	D	E	F	G	A	B	C
23	C	D	E	F	G	A	B
24	B	C	D	E	F	G	A
25	A G	B A	C B	D C	E D	F E	G F
26	F	G	A	B	C	D	E
27	E	F	G	A	B	C	D
28	D	E	F	G	A	B	C
Anni	1582 1600	1700	1800	1900 2000	2100	2200	2300 2400
Chr.	2500	2600	2700 2800	2900	3000	3100 3200	3300

			LXX	Ash.	East.	Asci.	Pent.	Corp. Christi.	Adv.
16	XXIII		*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*May*	*Nov.*
5	XXII	d	18	4	22	30	10	21	29
	XXI	e	19	5	23	*Ma.* 1	11	22	30
13	XX	f	20	6	24	2	12	23	*De.* 1
2	XIX	g	21	7	25	3	13	24	2
	XVIII	a	22	8	26	4	14	25	3
10	XVII	b	23	9	27	5	15	26	*No.*27
	XVI	c	24	10	28	6	16	27	28
18	XV	d	25	11	29	7	17	28	29
7	XIV	e	26	12	30	8	18	29	30
	XIII	f	27	13	31	9	19	30	*Dec.* 1
15	XII	g	28	14	*Ap.* 1	10	20	31	2
4	XI	a	29	15	2	11	21	*Jun.* 1	3
	X	b	30	16	3	12	22	2	*No.*27
12	IX	c	31	17	4	13	23	3	28
1	VIII	d	*Feb.* 1	18	5	14	24	4	29
	VII	e	2	19	6	15	25	5	30
9	VI	f	3	20	7	16	26	6	*Dec.* 1
	V	g	4	21	8	17	27	7	2
17	IV	a	5	22	9	18	28	8	3
6	III	b	6	23	10	19	29	9	*No.* 27
	II	c	7	24	11	20	30	10	28
14	I	d	8	25	12	21	31	11	29
3	*	e	9	26	13	22	*Jun.* 1	12	30
	XXIX	f	10	27	14	23	2	13	*Dec.* 1
11	XXVIII	g	11	28	15	24	3	14	2
	XXVII	a	12	*Ma.* 1	16	25	4	15	3
19	25.XXVI	b	13	2	17	26	5	16	*No.*27
8	XXV.XXIV	c	14	3	18	27	6	17	28
		d	15	4	19	28	7	18	29
		e	16	5	20	29	8	19	30
		f	17	6	21	30	9	20	*Dec.* 1
		g	18	7	22	31	10	21	2
		a	19	8	23	*Jun.* 1	11	22	3
		b	20	9	24	2	12	23	*No.* 27
		c	21	10	25	3	13	24	28

A Table to convert Sexagenary Degrees and Minutes into Decimals and the contrary.

1	00	37	10	73	20	109	30	145	40	181	50
2		38		74		110		146		182	
3		39		75		111		147		183	
4	01	40	11	76	21	112	31	148	41	184	51
5		41		77		113		149		185	
6		42		78		114		150		186	
7		43		79		115		151		187	
8	02	44	12	80	22	116	32	152	42	188	52
9		45		81		117		153		189	
10		46		82		118		154		190	
11	03	47	13	83	23	119	33	155	43	191	53
12		48		84		120		156		192	
13		49		85		121		157		193	
14		50		86		122		158		194	
15	04	51	14	87	24	123	34	159	44	195	54
16		52		88		124		160		196	
17		53		89		125		161		197	
18	05	54	15	90	25	126	35	162	45	198	55
19		55		91		127		163		199	
20		56		92		128		164		200	
21		57		93		129		165		201	
22	06	58	16	94	26	130	36	166	46	202	56
23		59		95		131		167		203	
24		60		96		132		168		204	
25		61		97		133		169		205	
26	07	62	17	98	27	134	37	170	47	206	57
27		63		99		135		171		207	
28		64		100		136		172		208	
29	08	65	18	101	28	137	38	173	48	209	58
30		66		102		138		174		210	
31		67		103		139		175		211	
32		68		104		140		176		212	
33	09	69	19	105	29	141	39	177	49	213	59
34		70		106		142		178		214	
35		71		107		143		179		215	
36	10	72	20	108	30	144	40	180	50	216	60

A Table to Convert Sexagenary Degrees and Minutes into Decimals and the contrary.

217	60	253	70	289	80	325	90	277777778
218		254		290		326		555555555
219		255		291		327		833333333
220	61	256	71	292	81	328	91	111111111
221		257		293		329		388888889
222		258		294		330		666666667
223		259		295		331		944444444
224	62	260	72	296	82	332	92	222222222
225		261		297		333		500000000
226		262		298		334		777777778
227	63	263	73	299	83	335	93	055555555
228		264		300		336		333333333
229		265		301		337		511111111
230		266		302		338		888888889
231	64	267	74	303	84	339	94	166666667
232		268		304		340		444444444
233		269		305		341		722222222
234	65	270	75	306	85	342	95	000000000
235		271		307		343		277777778
236		272		308		344		555555555
237		273		309		345		833333333
238	66	274	76	310	86	346	96	111111111
239		275		311		347		388888889
240		276		312		348		666666667
241		277		313		349		944444444
242	67	278	77	314	87	350	97	222222222
243		279		315		351		500000000
244		280		316		352		777777778
245	68	281	78	317	88	353	98	055555555
246		282		318		354		333333333
247		283		319		355		611111111
248		284		320		356		888888889
249	69	285	79	321	89	357	99	166666667
250		286		322		358		444444444
251		287		323		359		722222222
252	70	288	80	324	90	360	100	000000000

A Table to Convert Sexagenary Minutes into Decimals and the contrary.

	Minutes	Seconds	Thirds
1	00462962	00007716	00000128
2	00925925	15432	257
3	01388889	23148	385
4	01851851	30864	515
5	02314814	00038580	00000643
6	02777778	46296	771
7	03240740	54012	900
8	03703703	61728	1028
9	04166667	69444	1157
10	04629629	00077160	00001286
11	05092592	084876	1414
12	05555555	092592	1543
13	06018518	100308	1671
14	06481480	108024	1800
15	06944444	00115740	1929
16	07409407	123456	2057
17	07870370	131172	2186
18	08333333	138889	2314
19	08796296	146604	2443
20	09259259	00154320	2572
21	00722222	162036	2700
22	10185185	169752	2829
23	10648148	177468	2957
24	11111111	185184	3086
25	11574074	00192900	3215
26	12037037	200616	3343
27	12500000	208332	3472
28	12962962	216048	3600
29	13425926	223764	3729
30	13888889	00231481	00003858

	Minutes	Seconds	Thirds
31	14351852	00239670	00003986
32	14814814	246913	4115
33	15277777	254629	4243
34	15747040	262345	4372
35	16203703	270061	4581
36	16666666	00277777	00004629
37	17129629	285493	4758
38	17592592	293209	4886
39	18055555	300925	5015
40	18518518	308640	5144
41	18981481	00316356	00005272
42	19444444	324072	5401
43	19907407	331788	5529
44	20370370	339504	5658
45	20833333	347220	5787
46	21296296	00354936	00005915
47	21759259	362652	6044
48	22222222	370370	6172
49	22685185	378084	6301
50	23148148	385802	6430
51	23611111	00393518	00006558
52	24074074	401234	6687
53	24537037	408950	6815
54	25000000	416666	6944
55	25462963	424382	7073
56	25925926	00432098	00007201
57	26388888	439814	7330
58	26851852	447530	7458
59	27314814	455256	7587
60	27777777	00462962	00007716

A Table Converting Hours and Minutes into Degrees and Minutes of the *Æquator*, and into

	Hours.		Minutes
1	04.16666667	1	0.06944444
2	08.33333333	2	0.13888888
3	12.5	3	0.20833333
4	16.16666667	4	0.27777777
5	20.83333333	5	0.34722222
6	25.0	6	0.41666666
7	29.16666667	7	0.48611111
8	33.33333333	8	0.55555555
9	37.5	9	0.625
10	41.66666667	10	0.69444444
11	45.83333333	11	0.76388888
12	50.	12	0.83333333
13	54.16666667	13	0.90277777
14	58.33333333	14	0.97222222
15	62.5	15	1.04166666
16	66.66606667	16	1.11111111
17	70.83333333	17	1.18055555
18	75.00	18	1.25
19	79.16660667	19	1.31944444
20	83.33333333	20	1.38888888
21	87.5	21	1.45833333
22	91.66666667	22	1.52777777
23	95.83333333	23	1.59722222
24	100.00000000	24	1.66666666
		25	1.73611111
		26	1.80555555
		27	1.875
		28	1.94444444
		29	2.01388888
		30	2.08333333

The Decimal parts of a Day and the contrary.

Seconds		Minutes	Seconds
.00115740	31	2.15277777	.03587963
.00231481	32	2.22222222	.03703704
.00347222	33	2.29166666	.03819444
.00462962	34	2.36111111	.03935185
.00578703	35	2.43055555	.04050926
.00694444	36	2.5	.04166666
.00810184	37	2.56944444	.04282407
.00925925	38	2.63888888	.04398148
.01041660	39	2.70833333	.04513888
.01157405	40	2.77777777	.04629629
.01273148	41	2.84722222	.04745370
.01388888	42	2.91666666	.04861111
.01504630	43	2.98611111	.04976852
.01620371	44	3.05555555	.05092592
.01736111	45	3.125	.05208333
.01851853	46	3.19444444	.05324074
.01967593	47	3.26388888	.05439814
.02083333	48	3.33333333	.05555555
.02199074	49	3.40277777	.05671296
.02314810	50	3.47222222	.05787037
.02430555	51	3.54166666	.05902777
.02546295	52	3.61111111	.06018518
.02662037	53	3.68055555	.06134259
.02777777	54	3.75	.0625
.02893518	55	3.81944444	.06365741
.03009259	56	3.88888888	.06481481
.03125000	57	3.95833333	.06597222
.03240741	58	4.02777777	.06712963
.03356482	59	4.09722222	.06828704
.03472222	60	4.16666666	.06944444

A Catalogue of some of the most eminent Citties and Towns in *England* and *Ireland* wherein is shewed the difference of their Meridian from *London*, with the hight of the Pole.

Names of Citties	Differ. Merid.			Hight Pole
St. *Albons*	0	1	s	55.55
Barwick	0	6	s	55.49
Bedford	0	2	s	52.18
Bristol	0	11	s	51.32
Boston	0	0		53. 2
Cambridge	0	1	a	52.17
Canterbury	0	5	a	51.27
Carlile	0	10	s	54.57
Chester	0	11	s	53.20
Coventry	0	4	s	52.30
Carmarthen	0	17	s	52.2
Chichester	0	3	s	50.56
Colchester	0	5	a	52.4
Darby	0	5	s	53.6
Dublin in *Ireland*	0	26	s	53.11
Duresme	0	5	s	54.45
Dartmouth	0	15	s	50.32
Eely	0	1	a	52.20
Grantham	0	2	s	52.58
Glocester	0	9	s	52.00
Halefax	0	6	s	52.49
Hartford	0	1	s	52.50
Hereford	0	11	s	52.14
Huntington	0	1	s	52.19
Hull	0	1	s	53.58
Lancaster	0	11	s	54.08
Leicester	0	4	s	52.40

James Burgess his
book May 22 - 1847
Printed 1679.

Names of the Citties	Differ. Merid.	Hight Pole
Lincoln	0 1 s	53. 12
Middle of the Isle of Man	0 17 s	54. 22
Nottingham	0 4 s	53. 03
Newark	0 3 s	53. 02
Newcastle	0 6 s	54. 58
N. *Luffingham*	0 3 s	52. 41
Norwich	0 4 a	52. 44
Northampton	0 4 s	52. 18
Oxford	0 5 s	51. 54
Okenham	0 3 s	52. 44
Peterborough	0 2 s	52. 35
Richmond	0 6 s	54. 26
Rochester	0 3 a	51. 28
Ross	0 10 s	52. 07
St. *Michaels Mount in Cornwal*	0 23 s	50. 38
Stafford	0 8 s	52. 55
Stamford	0 2 s	52. 41
Shrewsbury	0 11 s	52. 48
Tredah in Ireland	0 27 s	53. 28
Uppingham in Rutland	0 3 s	52. 40
Warwick	0 6 s	52. 25
Winchester	0 5 s	50. 10
Waterford in Ireland	0 27 s	52. 22
Worcester	0 9 s	52. 20
Yarmouth in Suffolk	0 6 a	52. 45
York	0 4 s	54. 00
London	0 00	51. 32

The Suns mean Longitude and mean Anomaly in Ægyptian Years.

	☉ Mean Longitude	☉ Mean Anomaly
1	99.93364 37563	99.92889 33116
2	99.86728 75126	99.85778 66232
3	99.80093 12690	99.78667 99348
4	99.73457 50253	99.71557 32465
5	99.66821 87816	99.64446 65581
6	99.60186 25380	99.57335 98697
7	99.53550 62943	99.50225 31814
8	99.46915 00506	99.42114 64930
9	99.40279 38070	99.36003 98046
10	99.33643 75633	99.28893 31162
100	93.36437 56334	92.88933 11628
1000	33.64375 63341	28.89331 16289

The Suns Mean Anomaly and Præcession of the Æquinox in Ægyptian Years.

Year	☉ Mean Anomaly	Præcession Æquinox
1	99.92978 57316	00.00385 80246
2	99.85957 14632	00.00771 60493
3	99.78935 71949	00.01157 40740
4	99.71914 29265	00.01543 20987
5	99.64892 86582	00.01929 01234
6	99.57871 43898	00.02314 81481
7	99.50850 01114	00.02700 61728
8	99.29785 73164	00.03086 41975
9	99.36807 15847	00.03472 22221
10	99.29785 73164	00.03858 02469
100	92.97857 31642	00.38580 24691
1000	29.78573 16427	03.85802 46913

The Suns mean Longitude and mean Anomaly in Julian Years.

		☉ Mean Longitude	☉ Mean Anomaly	
				in 365d 5h 49
	1	99.93364 37563	99.92889 33116	92939 87116
	2	99.86728 75126	99.85778 66232	
	3	99.80093 12689	99.78667 99348	
B	4	00.00836 58301	99.98929 01234	
	5	99.94200 95864	99.91818 34350	
	6	99.87565 33427	99.84707 67466	
	7	99.80929 70990	99.77597 00583	
B	8	00.01673 16602	99.97858 02468	
	9	99.95037 54165	99.90747 35584	
	10	99.88401 91728	99.83636 68700	
	11	99.81766 29291	99.76525 91816	
B	12	00.02509 74903	99.96787 03702	
	13	99.95874 12466	99.89676 36818	
	14	99.89238 50029	99.82565 69934	
	15	99.82602 87592	99.75455 03050	
B	16	00.03346 33205	99.95716 04936	
	17	99.96710 70768	99.88605 48052	
	18	99.90075 08331	99.81494 81168	
	19	99.83439 45894	99.74384 14284	
B	20	00.04182 91506	99.9[illegible]645 06171	
	40	00.08365 83012	99.89290 12342	
	60	00.12548 74518	99.83935 18513	
	80	00.16731 66024	99.78580 24684	
	100	00.20914 57530	99.73225 308 5	
	200	00.41829 15060	99.46450 61710	
	300	00.62743 72590	99.19675 92565	
	400	00.83658 30120	98.92901 23420	
	500	01.04572 87650	98.66126 54275	
	600	01.25487 45180	98.39351 85130	
	700	01.46402 02710	98.12577 15985	

The ☉ mean Longitude and Anomaly

Æra	☉ mean Longitude	☉ mean Anomaly
Chr.	77.22400.86419	58.24289.56790
1600	80.54891.97529	53.95880.62961
1620	80.59074.89035	53.90525.69132
1640	80.63257.80541	53.85170.75303
1660	80.67440.72047	53.79815.81474
1680	80.71623.63553	53.74460.87645
1700	80.75806.55059	53.69105.93816
1720	80.79989.46665	53.63750.99987
1740	80.84172.38171	53.58396.06158
1760	80.88265.29677	53.53041.12329
	☉ mean Lon. in Mon.	☉ mean Ano. in Mo.
Janu.	08.48751.49488	08.48711.14867
Febr.	16.15365.74832	16.15288.96037
Mar.	24.64117.24320	24.64000.10904
April	32.85489.65760	32.85333.47872
May	41.34241.15248	41.34044.62739
June	49.55613.56688	49.55377.99708
July	58.04365.06176	58.04089.14575
Aug.	66.53116.55664	66.52800.29442
Sept.	74.74488.97104	74.74133.66410
Octo.	83.23240.46592	85.22844.81277
Nov.	91.44612.88032	91.44178.18245
Dec.	99.93364.37563	99.92889.33116

In Anno Bissextili, post Februarium adde unum diem & unius dies motum.

The Suns mean Longitude and mean Anomaly in Days.

	☉ mean Longitude	☉ mean Anomaly
1	0.2737908048	0.2737777898
2	0.5475816096	0.5475555796
3	0.8213724144	0.8213333694
4	1.0951632192	1.0951111592
5	1.3689540240	1.3688889490
6	1.6427448288	1.6426667388
7	1.9165356336	1.9164445286
8	2.1903264384	2.1902223184
9	2.4641172432	2.4640001082
10	2.7379080480	2.7377778980
11	3.0116988528	3.0115556878
12	3.2854896576	3.2853334776
13	3.5592804624	3.5591112674
14	3.8330712672	3.8328890572
15	4.1068620720	4.1066668470
16	4.3806428768	4.3804446368
17	4.6544436816	4.6542224266
18	4.9282344864	4.9280002164
19	5.2020252912	5.2077780062
20	5.4758160960	5.4755557960
21	5.7496069008	5.7493335858
22	6.0233977056	6.0231113756
23	6.2971885104	6.2968891654
24	6.5709793152	6.5706669552
25	6.8447701200	6.8444447450
26	7.1185609248	7.1182225348
27	7.3923517296	7.3920003246
28	7.6661425344	7.6957781144
29	7.9399333392	7.9395559042
30	8.2137241440	8.2133336940
31	8.4875149488	8.4871114838

912626016 hour

The Suns mean Longitude and mean Anomaly in ~~Days~~

	☉ Mean Longitude	☉ Mean Anomaly.
1	0.0114079502	0.0114074079
2	0.0228159004	0.0228148158
3	0.0342238506	0.0342222237
4	0.0456318008	0.0456296316
5	0.0570397510	0.0570370395
6	0.0684477012	0.0684444474
7	0.0798556514	0.0798518553
8	0.0912636016	0.0912592632
9	0.1026715518	0.1026666711
10	0.1140795020	0.1140740790
11	0.1254874522	0.1254814869
12	0.1368954024	0.1368888948
13	0.1483033526	0.1482963027
14	0.1597113028	0.1597037106
15	0.1711192530	0.1711111185
16	0.1825272032	0.1825185264
17	0.1939351534	0.1939259343
18	0.2053431036	0.2053333422
19	0.2167510538	0.2167407501
20	0.2281590040	0.2281481580
21	0.2395669542	0.2395555659
22	0.2509749044	0.2509629738
23	c.2623828546	0.2623703817
24	0.2737777048	0.2737777896

The Suns mean Anomaly and Præcession of the Æquinox.

Æra	☉ Anomaly.	Præceſſ. Æquinox
Chr.	56.69976.85185	20.49768.51851
1600	53.87323.10751	26.67052.46907
1620	53.83789.15687	26.74768.51845
1640	53.80255.20623	26.82484.56783
1660	53.76721.25559	26.90200.61721
1680	53.73187.30495	26.97916.66659
1700	53.69653 35431	27.05632.71597
1720	53.66119.40367	27.13348.76535
1740	53.65585.45303	27.21064.81473
1760	53.59051.50230	27.28780.86411
	☉ Anomaly in Months	Præceſſ. Æquinox in Months
Janu	08.48718.72813	0.00032.76678
Febr.	16.15303.38579	0.00062.36258
Mar.	24.64022.11392	0.00095.12937
April	32.85362.81857	0.00126.83916
May	41.34081.54670	0.00159.60594
June	49.55422.25134	0.00191.31573
July	58.04140.97947	0.00224.08251
Aug.	66.52859.70760	0.00256.84929
Sept.	74.74200.41225	0.00288.55908
Octo.	83.22919.14038	0.00321.32587
Nov.	91.44259.84502	0.00353.03566
Dec.	99.92978.57315	0.00385.80244

The ☉ mean Anomaly, and Præceſſion of the Æquinox in Julian Years.

in 365d 6h 17m		☉ mean Anomaly	Præceſſ. Æquinox
	1	99.9297857316	00.0038580246
	2	99.8595714632	00.0077160493
	3	99.7893571949	00.0115740740
B	4	99.9929231686	00.0154320987
	5	99.9227089002	00.0192901233
	6	99.8524946318	00.0231481479
	7	99.7822803634	00.0270061725
B	8	99.9858463372	00.0308641974
	9	99.9156320688	00.0347222220
	10	99.8454178004	00.0385802466
	11	99.7752035321	00.0424382714
B	12	99.9787695058	00.0462962961
	13	99.9085552374	00.0501543207
	14	99.8383409690	00.0540123453
	15	99.7681266066	00.0578703699
B	16	99.9716926744	00.0617283948
	17	99.9014784060	00.0655864194
	18	99.8312647376	00.0694444440
	19	99.7610498692	00.0733024686
B	20	99.9646158434	00.0771604938
	40	99.9292306868	00.1543209876
	60	99.8938465302	00.2314814814
	80	99.8584623736	00.3086419752
	100	99.8270782170	00.3858024690
	200	99.6461564340	00.7716049380
	300	99.4692346510	01.1574074070
	400	99.2923128680	01.5432098760
	500	99.1153910850	01.9290123450
	600	98.9384693020	02.3148148140
	700	98.7615475190	02.7006172830

The Suns mean Anomaly and Præc. of the Æqui. in Days.

D	☉ Anomaly	Præceſſ. Æquinox
1	0.2737802348	0.0000105699
2	0.5475604697	0.0000211398
3	0.8213407046	0.0000317097
4	1.0951209395	0.0000422797
5	1.3689011744	0.0000528496
6	1.6426814092	0.0000634195
7	1.9164616441	0.0000739894
8	2.1902418790	0.0000845593
9	2.4640221139	0.0000951292
10	2.7378023488	0.0001056993
11	3.0115825836	0.0001162692
12	3.2853628184	0.0001268391
13	3.5591430532	0.0001374090
14	3.8329232880	0.0001479789
15	4 1067035228	0.0001585488
16	4.3804837576	0.0001691187
17	4.6542639924	0.0001796886
18	4.9280442272	0.0001902585
19	4.2018244620	0.0002008284
20	5.4756046976	0.0002113986
21	5.7493849324	0.0002219685
22	6.0231651672	0.0002325384
23	6.2969454020	0.0002431083
24	6.5707256368	0.0002536782
25	6.8445058716	0.0002642481
26	7.1182861064	0.0002748180
27	7.3920663412	0'0002853879
28	7.6658455766	0.0002959580
29	7.9396258115	0.0003065279
30	8.2134070464	0.0003170979
31	8.4871872813	0.0003276678

The Suns mean Anomaly and Præc. of the Æqui. in Hours

D	☉ mean Anomaly	Præcess. Æquinox
1	0.0114075097	0.0000004404
2	0.0228150195	08808
3	0.0342225293	13212
4	0.0456300391	17616
5	0.0570375489	22020
6	0.0684450587	0.0000026424
7	0.0798525684	30828
8	0.0912600782	35232
9	0.1026675881	39636
10	0.1140750978	44041
11	0.1254826075	0.0000048445
12	0.1368901174	0.0000052849
13	0.1482976271	57253
14	0.1597051368	61657
15	0.1711126465	66061
16	0.1825201562	70465
17	0.1939276659	74869
18	0.2053351761	0.0000079272
19	0.2167426858	83677
20	0.2281501955	88081
21	0.2395577052	92485
22	0.2509652149	96889
23	0.2623727246	101293
24	0.2737802348	0.0000105698
24'	·00456300391	

James. Burgess

THE
TABLES
OF THE
MOONS
MEAN
MOTIONS.

The Moons mean Longitude and Apogeon

Æra	☾ Mean Longitude	☾ Apogæon
Chr.	34.0088734567	78.8286265432
1600	02.0644290122	63.5892746911
1620	39.1651134566	89.6540895059
1640	76.2658079010	15.7189033207
1660	13.3665023454	41.7837191355
1680	50.4671967898	67.8485339503
1700	87.5675912342	93.9133487651
1620	29.6685801230	19.9781635799
1740	61.7692801230	46.0429783947
1760	98.8699745674	72.1077932095
	☾ Mean Long. in Mon.	☾ Apogæon in Mont.
Janu.	13.4633984897	00.9593447922
Febr.	15.9464670933	01.8258497658
Mar.	29.4098665830	02.7851945580
April	39.2131554440	03.7135927440
May.	52.6765539337	04.6729375362
June	62.4798427947	05.6013357222
July	75.9432412844	06.5606805144
Aug.	89.4066397741	07.5200253066
Sept.	99.2099286451	08.4484234926
Octo.	12.6733271348	09.4077682848
Nov.	22.4766159958	10.3361664708
Dec.	35.9400144893	11.2955112636

The Moons mean Anomaly and Node Retrograde

Æra	☾ Mean Anomaly	☾ Node Retrograde
Chr.	55.1802469135	74.6984567901
1600	38.4751543211	78.2198302468
1620	49.5110239507	70.7638117283
1640	60.5469035803	63.3077932098
1660	71.5827832099	55.8517746913
1680	82.6186628395	48.3957561728
1700	93.6545424691	40.9397376543
1720	04.6904220987	33.4837191358
1740	15.7263017283	26.0277006173
1760	26.7621813579	18.5716820988

	☾ Mean Ano. in Mon.	Node Ret. in Mont.
Janu.	12.5040536975	00.4559979224
Febr.	14.7206183275	00.8678670136
Mar.	27.2246720250	01.3238649360
April	35.4995627000	01.7651532480
May.	48.0036163975	02.2211511704
June	56.8785070725	02.6624394824
July	69.3825607700	03.1184374048
Aug.	81.8866144675	03.5744353272
Sept.	90.7615051425	04.0157236392
Octo.	03.2655588400	04.4717215616
Nov.	12.1404495150	04.9130098736
Dec.	24.6445032256	05.3690078260

The Moons mean Motions in Julian Years.

		☾ Mean Longitude	☾ Apogæon
	1	35.9400144893	11.2955112636
	2	71.8800289786	22.5910225272
	3	07.8200434679	33.8865337908
B	4	47.4201388888	45.2129629629
	5	83.3601533781	56.5084742265
	6	19.3001678674	67.8039854901
	7	55.2401823567	79.0994967537
B	8	94.8402777777	90.4259259258
	9	30.7802922670	01.7214371894
	10	66.7203067563	13.0169484530
	11	02.6603212456	24.3124597166
B	12	42 2604166666	35.6388888888
	13	78.2004311559	46.9344001524
	14	14.1404456652	58.2299114160
	15	50.0804601545	69.5254226796
B	16	89.6805555555	80.8518518518
	17	25.6205700448	91.1473631154
	18	61.5605845341	02.4428743790
	19	97.5005990234	13.7383856426
B	20	37.1006944444	26.0648148148
	40	74.2013888888	52.1296296296
	60	11.3020833333	78.1944444444
	80	48.4027777777	04.2592592592
	100	85.5034722222	30.3240740740
	200	71.0069444444	60.6481481481
	300	56.5104166666	90.9722222222
	400	42.0138888888	21.2962962962
	500	27.5173611111	51.6203703702
	600	13.0208333333	91.9444444442
	700	98.5243055555	12.2685185182

The Moons mean Motions in Julian Years

		☾ Mean Anomaly	☾ Nodes Retrograde
	1	24.6445032256	05.3690078260
	2	49.2890064512	10.7380156520
	3	73.9335096768	16.1070234780
B	4	02.2071759259	21.4912037037
	5	26.8516791515	26.7602115297
	6	51.4951823771	32.1292193557
	7	76.1396856027	37.4982271817
B	8	04.4143518518	42.9824074074
	9	29.0588550774	48.3514152334
	10	53.7033583030	53.7204230594
	11	78.3478615286	59.0894308854
B	12	06.6215277777	64.4736111111
	13	31.2660310033	69.8426189371
	14	55.9105342289	74.2116267631
	15	80.5550374545	79.5806345891
B	16	08.8287037037	85.9648148148
	17	33.4732069293	91.3338226408
	18	58.1177101549	96.7028304668
	19	82.7622133805	02.0718382928
B	20	11.0358796297	07.4560185185
	40	22.0717592594	14.9120370370
	60	33.1076388891	22.3680555555
	80	44.1435185188	29.8240740740
	100	55.1793981487	37.2800925925
	200	10.3587962974	74.5601851850
	300	65.5381944461	11.8402777775
	400	20.7175925948	49.1203703700
	500	75.8969907435	86.4004629629
	600	31.0763888922	23.6805555555
	700	86.2557870409	60.9606481480

967025
29419
3677
99.9149

The Moons mean Motions in Days.

Days	☾ Mean Longitude	☾ Apogæon
1	03.6601096287	00.0309466062
2	07.3202192574	00.0618932124
3	10.9803288861	00.0928398186
4	14.6404385148	00.1237864248
5	18.3005481435	00.1547330310
6	21.9606577722	00.1856796372
7	25.6207674009	00.2166262434
8	29.2808770296	00.2475728496
9	32.9409866583	00.2785194558
10	36.6010962870	00.3094660620
11	40.2612059157	00.3404126682
12	43.9213155444	00.3713592744
13	47.5814251731	00.4023058806
14	51.2415348018	00.4332524868
15	54.9016444305	00.4641990930
16	58.5617540592	00.4951456992
17	62.2218636879	00.5260923054
18	65.8819733166	00.5570389116
19	69.5420829453	00.5879855178
20	73.2021925740	00.6189321240
21	76.8623022037	00.6498787302
22	80.5224118314	00.6808233364
23	84.1825214601	00.7117719426
24	87.8426310898	00.7427185488
25	91.5027407175	00.7736651550
26	95.1628503462	00.8046117612
27	98.8229599749	00.8355583674
28	02.4830696036	00.8665049736
29	06.1431792323	00.8974515798
30	09.8032888610	00.9283981860
31	13.4633984897	00.9593447922

The Moons mean Motions in Days.

Days	☾ Mean Anomaly	☾ Node Retrograde
1	03.6291630225	00.0147096104 5
2	07.2583260450	00.0294192208
3	10.8874890675	00.0441288312
4	14.5166520900	00.0588384416
5	18.1458151125	00.0735480520
6	21.7749781350	00.0882576624
7	25.4041411575	00.1029672728
8	29.0333041800	00.1176768832
9	32.6624672025	00.1323864936
10	36.2916302250	00.1470961040
11	39.9207932475	00.1618057144
12	43.5499562700	00.1765153248
13	47.1791192925	00.1912249352
14	50.8082823150	00.2059345456
15	54.4374453375	00.2206441560
16	58.0666083600	00.2353537664
17	61.6957713825	00.2500633768
18	65.3249344050	00.2647729872
19	68.9540974275	00.2794825976
20	72.5832604500	00.2941922080
21	76.2124234725	00.3089018184
22	79.8415864950	00.3236114288
23	83.4707495175	00.3383210392
24	87.0999125400	00.3530306496
25	90.7290755625	00.3677402600
26	94.3582385850	00.3824498704
27	97.9874016075	00.3971594808
28	01.6165646300	00.4118690912
29	05.2457276525	00.4265787016
30	08.8748906750	00.4412883120
31	12.5040536975	00.4559979224

1789

The Moons mean Motions in Hours.

Hours	☾ Mean Longitude	☾ Apogæon
1	00.1525045678	00.0012894419
2	00.3050091357	00.0025788838
3	00.4575137035	00.0038683257
4	00.6100182713	00.0041577676
5	00.7625228391	00.0064472095
6	00.9150274071	00.0077366515
7	01.0675319749	00.0090260934
8	01.2200365427	00.0103155353
9	01.3725411105	00.0116049772
10	01.5250456786	00.0128944192
11	01.6775502464	00.0141838611
12	01.8300548143	00.0154733031
13	01.9825593821	00.0167627450
14	02.1350639499	00.0180521869
15	02.2875685177	00.0193416288
16	02.4400730855	00.0206310707
17	02.5925776533	00.0219205126
18	02.7450822211	00.0232099545
19	02.8975867891	00.0244993964
20	03.0500913569	00.0257888384
21	03.2025959250	00.0270782803
22	03.3551004928	00.0283677222
23	03 5076050607	00.0296571642
24	03.6601096285	00.0309466061

The Moons mean Motions in Hours.

Hours	☾ Mean Anomaly	☾ Node Retrograde
1	00.1512151259	00.0006129004
2	00.3024302518	00.0012258008
3	00.4536453778	00.0018387013
4	00.6048605037	00.0024516017
5	00.7560756296	00.0030645021
6	00.9072907556	00.0036774026
7	01.0585058815	00.0042903030
8	01.2097210074	00.0049032034
9	01.3609361333	00.0055161038
10	01.5121512593	00.0061290043
11	01.6633663852	00.0067419047
12	01.8145815112	00.0073548052
13	01.9657966371	00.0079677056
14	02.1170117630	00.0085806060
15	02.2682268889	00.0091935064
16	02.4194420148	00.0098064068
17	02.5706571407	00.0104193072
18	02.7218722666	00.0110722076
19	02.8730873926	00.0116451081
20	03.9243025185	00.0122580085
21	03.1755176445	00.0128709090
22	03.3267327704	00.0134838094
23	03.4779478964	00.0140967099
24	03.6291630223	00.0147096103

The Moons mean Motions in Minutes of an Hour

M.	☾ M. Long.	☾ Apog.	☾ M. Au.	☊ Retrog.
1	.0025414	.0000214	.0025202	.0000102
2	.0050828	.0000429	.0050405	.0000204
3	.0076242	.0000643	.0075607	.0000306
4	.0101656	.0000859	.0100810	.0000408
5	.0127070	.0001074	.0126012	.0000510
6	.0152484	.0001288	.0151214	.0000612
7	.0177898	.0001502	.0176416	.0000714
8	.0203312	.0001716	.0201618	.0000816
9	.0228726	.0001930	.0226820	.0000918
10	.0254141	.0002149	.0252025	.0001021
11	.0279555	.0002363	.0277227	.0001123
12	.0304969	.0002577	.0302429	.0001225
13	.0330383	.0002791	.0327631	.0001327
14	.0355797	.0003004	.0352833	.0001429
15	.0381211	.0003218	.0378035	.0001531
16	.0406624	.0003432	.0403237	.0001633
17	.0432038	.0003646	.0428439	.0001735
18	.0457452	.0003860	.0453641	.0001837
19	.0482867	.0004079	.0478843	.0001939
20	.0508284	.0004293	.0504045	.0002041
21	.0533696	.0004512	.0529247	.0002143
22	.0559110	.0004726	.0554449	.0002245
23	.0584524	.0004940	.0579651	.0002347
24	.0609938	.0005154	.0604853	.0002442
25	.0635352	.0005368	.0630055	.0002544
26	.0660766	.0005582	.0655257	.0002642
27	.0686180	.0005795	.0680459	.0002744
28	.0711594	.0006008	.0705661	.0002846
29	.0737008	.0006222	.0730863	.0092948
30	.0762422	.0006437	.0756075	.0003064

The Moons mean Motions in Seconds.

	☾ M.Long.	☾ Apog.	☾ M. An.	☊ Retrog.
1	0000423	0000003	0000420	0000002
2	0000847	0000007	0000840	0000003
3	0001270	0000010	0001260	0000005
4	0001693	0000013	0001680	0000006
5	0002116	0000016	0002100	0000009
6	0002539	0000019	0002520	0000010
7	0002969	0000022	0002940	0000012
8	0003392	0000025	0003360	0000013
9	0003815	0000028	0003780	0000015
10	0004275	0000035	000[illegible]200	0000017
11	0004658	0000038	0004620	0000019
12	0005078	0000041	0005040	0000020
13	0005504	0000044	0005460	0000022
14	0005930	0000047	0005880	0000023
15	0006357	0000050	0006300	0000025
16	0006784	0000053	0006720	0000027
17	0007207	0000056	0007140	0000028
18	0007630	0000059	0007560	0000029
19	0008050	0000062	0007980	0000031
20	0008470	0000065	0008400	0000033
21	0008893	0000068	0008820	0000035
22	0009316	0000071	0009240	0000036
23	0009736	0000074	0009660	0000038
24	0010156	0000077	0010080	0000039
25	0010582	0000080	0010500	0000041
26	0011008	0000083	0010920	0000043
27	0011434	0000086	0011340	0000044
28	0011860	0000089	0011760	0000047
29	0012287	0000092	0012180	0000049
30	0012714	0000095	0012600	0000051

☉	Sig. 0. &. 6		1 & 7		2 & 8		☉
☊	Æqu. ☊ Addi	Inclin. limetis	Æqu. ☊ Addi	Inclin. limitis	Æqu. ☊ Addi	Inclin. limitis	☊
0	0.00000	30000	1.06500	26000	1.08500	15000	30
1	0.00000	30000	1.12888	25722	1.01888	14527	29
2	0.00055	30000	1.19277	25472	0.95305	14055	28
3	0.00194	29972	1.25222	25166	0.88666	13583	27
4	0.00416	29944	1.30833	24888	0.82055	13138	26
5	0.00888	29888	1.36166	24583	0.75333	12666	25
6	0.01472	29833	1.41055	24277	0.68694	12194	24
7	0.02305	29777	1.45666	23972	0.62416	11722	23
8	0.02416	29722	1.49916	23638	0.56444	11250	22
9	0.04805	29638	1.53666	23305	0.50555	10750	21
10	0.06500	29555	1.58000	22972	0.44666	10250	20
11	0.08555	29444	1.60027	22638	0.38888	09750	19
12	0.10944	29361	1.62527	22277	0.34000	09250	18
13	0.13666	29250	1.64472	21916	0.28972	08750	17
14	0.16833	29111	1.65771	21555	0.25083	08250	16
15	0.20250	28972	1.66277	21222	0.20972	07750	15
16	0.24111	28833	1.65805	20833	0.17388	07250	14
17	0.27472	28667	1.64527	20444	0.14138	06750	13
18	0.32944	28567	1.62638	20055	0.11305	06250	12
19	0.37916	28361	1.60194	19666	0.08805	05722	11
20	0.43277	28194	1.58222	19277	0.06722	05222	10
21	0.48888	28027	1.53972	18861	0.04916	04694	9
22	0.54833	27833	1.50333	18444	0.03416	04166	8
23	0.60694	27611	1.46222	18027	0.02333	03638	7
24	0.66833	27416	1.41777	17611	0.01500	03138	6
25	0.73555	27194	1.37027	17194	0.00888	02611	5
26	0.79805	26972	1.31861	16750	0.00416	02083	4
27	0.86416	26722	1.26527	16333	0.00194	01555	3
28	0.93083	26500	1.20833	15888	0.00055	01027	2
29	0.99611	26250	1.14750	15444	0.00000	00527	1
30	1.06500	26000	1.08500	15000	0.00000	00000	0
	Subtract.		Subtract.		Subtract.		
	Sig. 5. & 11		4 & 10		3 & 9		

Aug. Lat.	Sig.0. N. Sig.6. S. Latit.	Incr. or Exc.	1. North 7. South Latit.	Incr. or Exc.	2. North 8. South Latit.	Incr. or Exc.	
0	0.00000	00000	2.49750	15000	4.32888	26000	30
1	0.08722	00527	2.57277	15444	4.37166	26250	29
2	0.17444	01027	2.64722	15888	4.41361	26500	28
3	0.26166	01555	2.72083	16333	4.45388	26722	27
4	0.34861	02083	2.79361	16416	4.49277	26972	26
5	0.43555	02611	2.86555	17194	4.53055	27194	25
6	0.52222	03138	2.93638	17611	4.56666	27416	24
7	0.60888	03638	3.00666	18027	4.60166	27611	23
8	0.69527	04166	3.07583	18444	4.63500	27833	22
9	0.78138	04694	3.14416	18861	4.66722	28027	21
10	0.86722	05222	3.21166	19277	4.69777	28194	20
11	0.95277	05722	3.27805	19666	4.72694	28361	19
12	1.03833	06250	3.34333	20055	4.75472	28527	18
13	1.12333	06750	3.41055	20444	4.78111	28666	17
14	1.20805	07250	3.47111	20833	4.80583	28833	16
15	1.29250	07750	3.53333	21222	4.82916	28972	15
16	1.37666	08250	3.59444	21555	4.85111	29111	14
17	1.46027	08750	3.65472	21916	4.87166	29250	13
18	1.54333	09250	3.71361	22277	4.89055	29361	12
19	1.62611	09750	3.77138	22638	4.90777	29444	11
20	1.70805	10250	3.82833	22972	4.9[illegible]388	29555	10
21	1.78972	10750	3.88388	23305	4.93833	29638	9
22	1.87111	11250	3.93805	23638	4.95111	29722	8
23	1.95166	11722	3.99138	23972	4.96250	29777	7
24	2.03166	12194	4.04333	24277	4.97250	29833	6
25	2.11083	12666	4.09416	24583	4.98083	29888	5
26	2.18972	13138	4.14361	24888	4.98777	29944	4
27	2.26777	13583	4.19166	25166	4.99301	29972	3
28	2.34500	14055	4.23861	25472	4.99694	29972	2
29	2.42166	14527	4.28444	25722	4.99916	18000	1
30	2.49750	15000	4.32888	26000	5.00000	[illegible]000	0
	Sig.11.S. Sig.5.N.		Sig.10.S. 4 N.		9. South 3. North		

As Lat.	Sig. 0. 6 Red.	Incr.	S. 1. 7 Red.	Incr.	S. 2. 8 Red.	Incr.	As Lat.
0	.00000	00000	09444	01166	09472	01166	30
1	.00388	00055	09638	01194	09277	01138	29
2	.00750	00111	09805	01222	09055	01111	28
3	.01138	00166	09972	01250	08833	01083	27
4	.01527	00222	10111	01277	08611	01055	26
5	.01888	00250	10250	01277	08388	01027	25
6	.02277	00305	10388	01277	08138	01000	24
7	.02638	00333	10500	01305	07861	00972	23
8	.03000	00361	10583	01305	07611	00944	22
9	.03361	00416	10666	01305	07305	00916	21
10	.03722	00472	10750	01333	07027	00861	20
11	.04083	00527	10805	01333	06722	00833	19
12	.04444	00555	10861	01333	06416	00805	18
13	.04777	00611	10888	01333	06111	00777	17
14	.05111	00638	10916	01361	05805	00722	16
15	.05444	00666	10916	01361	05472	00666	15
16	.05777	00722	10916	01361	05138	00638	14
17	.06111	00777	10862	01361	04805	00611	13
18	.06416	00805	10861	01361	04444	00555	12
19	.06722	00833	10805	01333	04111	00527	11
20	.07000	00861	10750	01333	03750	00472	10
21	.07305	00916	10694	01305	03388	00416	9
22	.07583	00944	10611	01305	03027	00361	8
23	.07888	00972	10500	01305	02092	00333	7
24	.08111	01000	10388	01277	02611	00305	6
25	.08361	01027	10277	01277	02222	00250	5
26	.08583	01055	10138	01277	01527	00222	4
27	.08823	01083	10000	01250	01138	00166	3
28	.09055	01111	09833	01222	00750	00111	2
29	.09250	01138	09638	01194	00388	00055	1
30	.09444	01166	09472	01166	00000	00006	0
	11. 5		10. 4		9. 3		

A Table shewing the mean Motion of the Moon from the Sun in Years and Months.

Æra	☾ à ☉ in Years		☾ à ☉ in Years
Chr.	56.8114797531	1	36.0063707331
1600	21.5206732464	2	72.0127414662
1620	58.5795367034	3	08.0191121993
1640	95.6384101604	4	47.4117836215
1660	32.6972836174	5	83.4181543546
1680	69.7561560744	6	19.4245250877
1700	06.8150305314	7	55.4308958208
1720	43.8739039884	8	94.8235672430
1740	80.9027774454	9	40.8298379761
1760	17.9916509024	10	76.8362087092
		11	02.8426794423
	Motion of the	12	42.2353508645
	Moon from the	13	78.2417215976
	Sun in Months.	14	14.2480923307
		15	50.2544630638
Jan.	04.9758835440	16	89.6471344860
Feb.	99.7928106160	17	25.6535052191
Mar.	04.7686941600	18	61.6598759522
April	06.3582588800	19	97.6662466853
		20	37.0589181075
May	11.3341424240	40	74.1178362150
June	12.9237071440	60	11.1767543225
July	17.8995906880	80	48.2356724300
Aug.	22.8754742320	100	85.2945905375
		200	70.5891810750
Sept.	24.4650389520	300	55.8837716125
Octo.	29.4409224960	400	41.1783621500
		500	26.4729526875
Nov.	31.0304872160	600	11.7675432250
Dec.	36.0063707331	700	97.0621337625

A Table shewing the mean Motion of the Moon from the Sun in Days and Hours.

	☾ à ☉ in Days.		☾ à ☉ in Hours.
1	03.3863188240	1	00.1410966176
2	06.7726376480	2	00.2821932352
3	10.1589564720	3	00.4232898530
4	13.5452752960	4	00.5643864706
5	16.9315941200	5	00.7054830882
6	20.3179129440	6	00.8465797060
7	23.7042317680	7	00.9876763236
8	27.0905505920	8	01.1287729412
9	30.4768694160	9	01.2698695588
10	33.8631882400	10	01.4109661766
11	37.2495070640	11	01.5520627942
12	47.6358258880	12	01.6931594120
13	44.0221447720	13	01.8342560296
14	47.4084635360	14	01.9753526472
15	50.7947823600	15	02.1164492648
16	54.1811011840	16	02.2575458824
17	57.5674200080	17	02.3986425000
18	60.9537388320	18	02.5397391176
19	64.3400576560	19	02.6808357354
20	67.7263764800	20	02.8219323520
21	71.1126953040	21	02.9630289708
22	74.4990141280	22	03.1041255884
23	77.8853329520	23	03.2452222062
24	81.2716517760	24	03.3863188240
25	84.6579706000		
26	88.0442894240		
27	91.4306082480		
28	94.8169270720		
29	98.2032458960		
30	01.5895647200		
31	04.9758835440		

A Table shewing the mean Motion of the Moon from the Sun in Minutes.

	☾ à ☉ in Minutes.		☾ à ☉ in Minutes.
1	00.0023516102	31	00.0728999183
2	00.0047032205	32	00.0752515088
3	00.0070548308	33	00.0776031390
4	00.0094064411	34	00.0799547492
5	00.0117580513	35	00.0823063591
6	00.0141096617	36	00.0846579696
7	00.0164612719	37	00.0870095798
8	00.0188128822	38	00.0893611900
9	00.0211644924	39	00.0917128002
10	00.0235161029	40	00.0940644104
11	00.0258677131	41	00.0964160206
12	00.0262193233	42	00.0997676308
13	00.0305709335	43	00.1011192410
14	00.0329225437	44	00.1034708512
15	00.0352741539	45	00.1058224614
16	00.0376257644	46	00.1081740716
17	00.0399773746	47	00.1105256818
18	00.0423289848	48	00.1128772920
19	00.0446805950	49	00.1152289022
20	00.0470322052	50	00.1175805124
21	00.0493838154	51	00.1199321226
22	00.0517354256	52	00.1222837328
23	00.0540870358	53	00.1246353430
24	00.0564386460	54	00.1269869532
25	00.0587902562	55	00.1293385634
26	00.0611418664	56	00.1316901736
27	00.0634934766	57	00.1340417838
28	00.0658450868	58	00.1363933940
29	00.0681966970	59	00.1387450050
30	00.0705483080	60	00.1410966152

A Table ſhewing the mean Motion of the Moon from the Sun in Seconds.

	☾ à ☉ in Seconds		à ☉ in Seconds
1	00.0000391935	31	00.0012149985
2	00.0000783870	32	00.0012541920
3	00.0001175805	33	00.0012933855
4	00.0001567740	34	00.0013325790
5	00.0001959675	35	00.0013717725
6	00.0002351610	36	00.0014109660
7	00.0002743545	37	00.0014501595
8	00.0003135480	38	00.0014893530
9	00.0003527415	39	00.0015285465
10	60.0003919350	40	00.0015677400
11	00.0004311285	41	00.0016069335
12	00.0004703220	42	00.0016461270
13	00.0005995155	43	00.0016853205
14	00.0005487090	44	00.0017245140
15	00.0005879025	45	00.0917637075
16	00.0006270960	46	00.0018029010
17	00.0006662895	47	00.0018420945
18	00.0007954830	48	00.0018812880
19	00.0007446765	49	00.0019204815
20	00.0007838700	50	00.0019596750
21	00.0008230635	51	00 0019988685
22	00.0008622570	52	00.0020380620
23	00.0009014505	53	00.0020772555
24	00.0009406440	54	00.0021164490
25	00.0009798375	55	00.0021556425
26	00.0010190310	56	00.0021948360
27	00.0010582245	57	00.0022340295
28	00.0010974180	58	00.0022732230
29	00.0011366115	59	00.0023124165
30	00.0011758050	60	00.0023516100

A Catalogue of ſome of the moſt notable fixed Stars according to the obſervations of *Tycho Brahe*, and by him rectified to the beginning of the Year of Mans Redemption, 1601.

The Names of the Stars	Longit.		Latit.	
The firſt Star of Aries.	07.671	♈	7.8. N	4
The bright Star in the top of the head of Aries.	00.583	♉	9.57.N	3
The South Eye of Taurus.	01.169	♊	5.32. S	1
The North Eye of Taurus.	00.801	♊	5.31.S	1
The bright Star of the Pleiades.	06.620	♉	2. 6. S	3
The higher head of Gemini.	04.078	♋	4.11.N	5
The lower head of Gemini.	04.921	♋	10.2.N	2
The bright foot of Gemini.	01.069	♋	6.38.N	2
In the South Arm of Cancer.	02.238	♌	6.48. S	2
The bright Star in the neck of Leo.	06.662	♌	5.8. S	3
The heart of Leo.	06.745	♌	8.47.N	2
In the extream of the tail of Leo.	04.458	♍	0.26.N	1
In Virgo's *Wing*; Vindemiatrix.	01.217	♎	12.18.N	1
Virgins Spike.	05.074	♎	16.15.N	3
South Ballance.	02.643	♏	1.59. S	1
North Ballance.	03.833	♏	0.26. N	2
The higheſt in the Forehead of Scorpio.	07.388	♏	8.35.N	2
The Scorpions heart.	01.171	♐	1.05. N	3
Former of the 3 in the head of Sagittarius.	02.203	♑	4.27. S	1
Northern in the former horn of Capricorn.	07.861	♑	1.24. N	4
The left Shoulder of Aquarius.	04.949	♒	7.22. N	3
In the mouth of the South Fiſh.	03.620	♓	8.42. N	3
The Polar Star or laſt Star in the tail of the leſſer Bear.			9.4. N	5
	06.400	♊	66.02.N	2

The Names of the Stars.	Longit.		Latit.	
The last Star in the tail of the great Bear,	05.888	♍	54.25.N	2
The Tongue of the Dragon.	05.259	♏	76.17.N	4
Arcturus *in the skirt of his Garment.*	05.181	♎	31.2. N	1
The bright Star of the North Crown.	01.845	♏	44.23.N	2
The Head of Hercules.	02.921	♐	37.23.N	3
The bright Star of the Harp.	02.699	♑	61.47.N	1
The Head of Medusa.	05.727	♉	22.22.N	3
The bright Star in the Goats left Shoulder.	04.518	♊	22.50.N	1
The middle of the Serpents Neck.	04.583	♍	25.35.N	2
The bright Star in the Eagles Shoulder.	07.264	♑	29.21.N	2
The bright Star in the Dolphins Tail.	02.370	♒	29. 8.N	3
The mouth of Pegasus.	07.324	♒	22. 7.N	3
The head of Andromeda.	02.440	♈	25.42.N	2
In the top of the Triangle.	00.366	♉	16.49.N	4
In the Snout of the Whale.	02.643	♉	7.50. S	
The bright Star in the Whales Tail.	07.481	♓	20.47. S	2
Bright Shoulder of Orion.	06.444	♊	16.06 S	2
Middlemost in the belt of Orion.	04,972	♊	24.33. S	2
The last in the tail of the Hare.	07.324	♊	38.26. S	4
The great Dogs mouth Sirius.	02.386	♋	38.30. S	1
The lesser Dog Procyon.	05.641	♋	15.57. S	2
In the top of the Ships Stern.	01.636	♌	43.18. S	3
Brightest in Hydra's *Heart.*	06.044	♌	22.24. S	1

Jos Burgess

FINIS.

THE

CONTENTS

OF THE

First Part,

CONTAINING

The Practical Geometry or the Art of Surveying.

Tables.

THE

The Contents of the Second Part of this Treatise, of the Doctrine of the PRIMUM MOBILE. 224

The Contents of the Third Part of this Treatise, being an Account of the Civil Year with the reason of the difference between the Julian and Gregorian Calendars, and the manner of Computing the Places of the Sun and Moon. 309

The Contents.

Chap.

The

The Fourth Part, or an Introduction to Geography.

A

The Contents.

Books

Books Printed for and ſold by Thomas Paſ-ſinger *at the* Three Bibles *on the middle of* London-Bridge.

THe Elements of the Mathematical Art, commonly called *Algebra*, expounded in four Books by *John Kerſey*, in two Vol. *fol.*

A mirror or Looking-glaſs for Saints and Sinners, ſhewing the Juſtice of God on the one, and his Mercy towards the other, ſet forth in ſome thouſands of Examples by *Sam. Clark*, in two Vol. *fol.*

The Mariners Magazine by Capt. *Sam. Sturmy*, *fol.*

Military and Maritime Diſcipline in three Books, by Capt. *Tho. Venn*, *fol.*

Dr. *Cudworth*'s univerſal Syſteme.

The Triumphs of Gods Revenge againſt the Crying and Execrable ſin of wilful and premeditated Murther, by *John Reynolds*, *fol.*

Royal and Practical Chymiſtry by *Oſwaldus Crollius* and *John Hartman*, faithfully rendred into Engliſh, *fol.*

Practical Navigation by *John Seller*, *Quarto.* J. Mount & T. Page Towerhill 1774

The Hiſtory of the Church of Great *Britain* from the Birth of our Saviour until the Year of our Lord 1667. *quarto.*

The Eccleſiaſtical Hiſtory of *France* from the firſt plantation of Chriſtianity there unto this time, *quarto.*

The book of Architecture by *Andrea Palladio*, *quarto.*

The

The mirror of Architecture or the ground Rules of the Art of Building, by *Vincent Scammozi* *quarto.*

Trigonometry, or the Doctrine of Triangles, by *Rich. Norwood, quarto.* excellent man

Markham's Master-piece Revived, containing all knowledge belonging to the Smith, Farrier, or Horse-Leach, touching the curing of all Diseases in Horses, *quarto.*

Collins Sector on a Quadrant, *quarto.*

The famous History of the destruction of *Troy,* in three books, *quarto.*

Safeguard of Sailers, *quarto.*

Norwood's Seamans Companion, *quarto.*

Geometrical Seaman, *quarto.*

A plain and familiar Exposition of the Ten Commandments, by *John Dod, quarto.*

The Mariners new Calendar, *quarto.*

The Seamans Calendar, *quarto.*

The Seamans Practice, *quarto.* R. Norwood

The honour of Chivalry, or the famous and delectable History of *Don Belianus of* Greece, *quarto.*

The History *of Amadis de Gaul,* the fifth part, *quarto.*

The Seamans Dictionary, *quarto.*

The complete Canonier, *quarto.*

Seamans Glass, *quarto.*

Complete Shipwright, *quarto.*

The History of *Valentine* and *Orson, quarto.*

The Complete Modellist, *quarto.*

The Boat-swains Art, *quarto.*

Pilots Sea-mirror, *quarto.*

The famous History of *Montelion* Knight of the Oracle, *quarto.*

The History of *Palladine* of *England, quarto.*

The

The History of *Cleocretron* and *Cloriana*, *quarto*.

The Arraignment of lewd, idle, froward and unconstant Women, *quarto*.

The pleasant History of *Jack* of *Newbery*, *quarto*

Philips Mathematical Manual, *Octavo*.

A prospect of Heaven, or a Treatise of the happiness of the Saints in Glory; *oct*.

Etymologicum parvum, *oct*.

Thesaurus Astrologiæ, or an Astrological Treasury by *John Gadbury*, *oct*.

Gellibrand's Epitome, *oct*. of Navigation 1774

The English Academy or a brief Introduction to the seven Liberal Arts, by *John Newton*, D.D. *oct*.

The best exercise for Christians in the worst times, by *J. H.* *oct*.

A seasonable discourse of the right use and abuse of Reason in matters of Religion, *oct*.

The Mariners Compass rectified, *oct*.

Norwood's Epitome, *oct*.

Chymical Essays by *John Beguinus*, *oct*.

A spiritual Antidote against sinful Contagions, by *Tho. Doolittle*, *oct*.

Monasticon Feveshamiense, or a description of the Abby of *Feversham*, *oct*.

Scarborough's Spaw, *oct*.

French Schoolmaster, *oct*.

The Poems of *Ben. Johnson*, *junior*, *oct*.

A book of Knowledge in three parts, *oct*. little kettel

The Book of Palmestry, *oct*.

Farnaby's Epigramms, *oct*.

The Huswifes Companion, and the Husbandmans Guide, *oct*.

Jovial Garland, *oct*.

Cocker's Arithmetick, *twelves*.

The Path Way to Health, *twelves*.

Hall's Soliloquies, *twelves*.

The

The Complete Servant Maid, or the young Maidens Tutor, *twelves.*
Newton's Introduction to the Art of Logick, *twelves.*
Newton's Introduction to the Art of Rhetorick, *twelves.*
The Anatomy of Popery, or a Catalogue of Popish errors in Doctrine and corruptions in Worship, *twelves.*
The famous History of the five wise Philosophers, containing the Life of *Jehosophat* the Hermit. *twelves,*
The exact Constable with his Original and Power in all cases belonging to his Office, *twelves.*
The Complete Academy or a Nursery of Complements, *twelves.*
Heart salve for a wounded Soul, and Eye salve for a blind World, by *Tho. Calvert. twelves.*
Pilgrims Port, or the weary mans rest in the Grave, *twelves.*
Christian Devotion or a manual of Prayers, *twelves.*
The Mariners divine Mate, *twelves.*

1686

James Burgess Book

FINIS.

u-

er-

n-

all

ts,

nd

es.

ht
g,
g,
se
he
nd
nd
n :
in

on.